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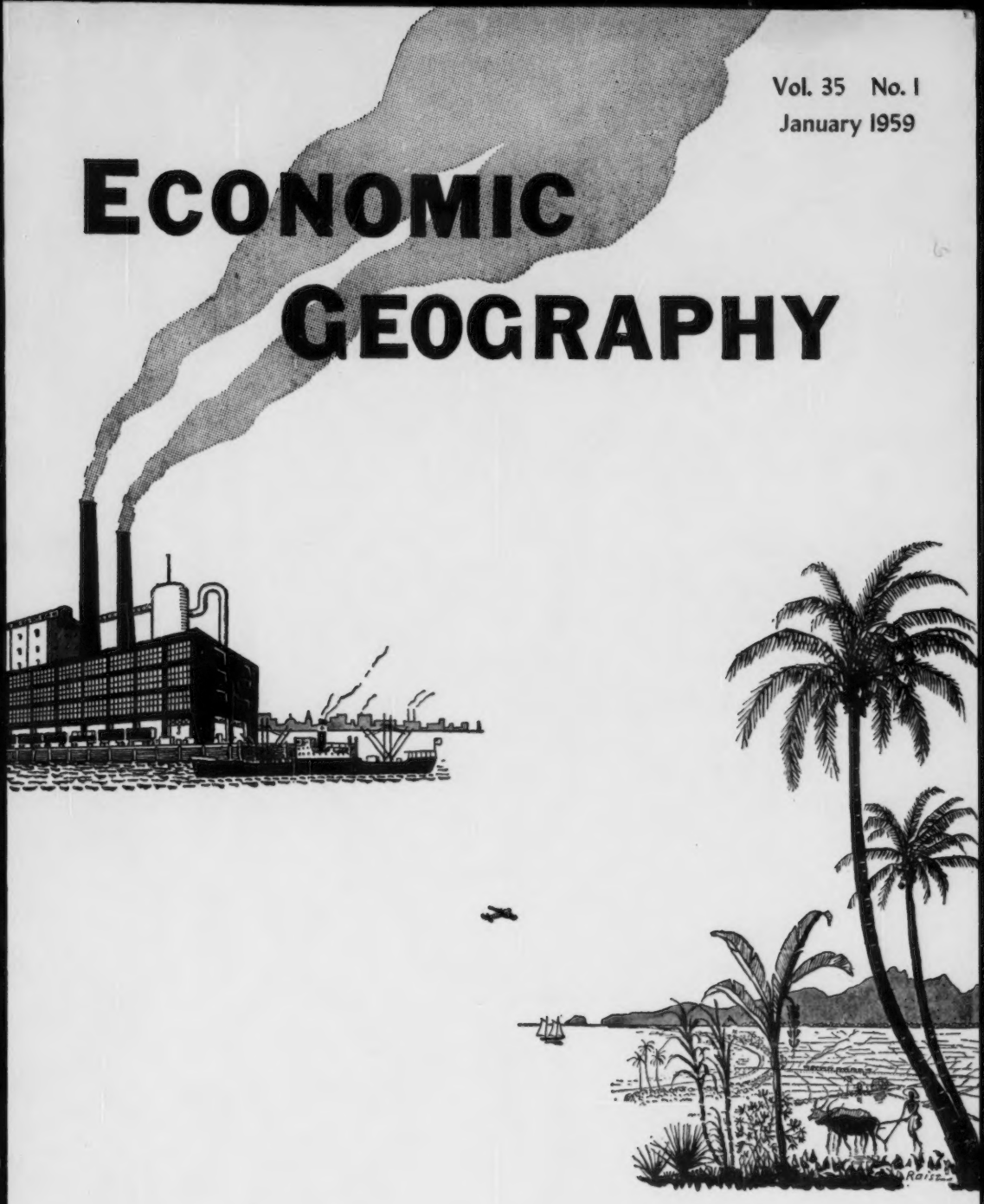

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Guest Editorial

"MERE DESCRIPTION"

"Description" has become a dirty word. This is evidenced by the adjectives with which it is usually modified; strangely enough "mere" and "pure" have the same derogatory meaning when used in this connection. This jade comes from a very respectable family, "Exploration," but values have changed, and what was never "mere" when it was roughly measured by day's journeys is prostitution of the geographic art when it results in detailed maps of observed and measured phenomena. The tradition of literature and drama is that fallen women are sterling characters at heart and are redeemable by love and understanding: perhaps geographers may do as much for "mere description!"

The objections to mere description most commonly advanced are that, by itself, it generates no theories and that, actually, a certain amount of hypothesis is necessary before it can be decided what and how to describe. There is a modicum of validity to both of these objections, but experience is also replete with evidence to the contrary. It is true that the routine compiler of measurements or observer of phenomena *may* derive no theories from his data, but how often he does just the opposite!

That description is impossible without theories to start with is one of those widely-accepted statements that deserves more examination than it has gotten. We do, of course, owe the collection of a great deal of our stock of information to the necessity to test a hypothesis. It may or may not support the hypothesis, but the information remains.

A quarter of a century ago V. C. Finch described a methodology for urban geography in the following words: ". . . It puts to the fore that aspect of the subject upon which the writer speaks with authority; the present city. It puts in its proper place that body of deductions . . . which, however well they may have been developed, . . . still are deductions. A century hence the recorded observations of landscape may be worth much, the deductions little."

If the description promises to be the only part of many studies that will stand the test of time, shouldn't every effort be made to do it very well indeed? And, if the data gathered to test our hypotheses are going to be used as grist for other mills, shouldn't its gathering and presentation be a disciplined procedure with its potential users in mind?

These questions are raised anew, here, because the need and opportunities for useful non-theoretical descriptions are greater than ever. The amount of data becomes overwhelming. Air-photo coverage, for example, is available for large areas, especially in the United States. From this it is possible to determine, with great accuracy, the distribution of urbanized areas, forests, agricultural areas, etc. Boundaries may be located and measurements made on scales from 1:20,000 down.

Indeed, this embarrassment of riches may necessitate new methods of thinking by geographers. Their descriptive generalizations (regionalizations) until now have often been based on assumed relationships. Some of this has been more or less unconscious, with economic or cultural phenomena poured into a mold of geologic—or political—regionalization. Now that there is detailed information, the challenge is to come up with non-theoretical descriptive generalization at usable, smaller scales, yet retain as much as possible of the form and pattern of the actual distribution.

It is *not* being argued here that theories, hypotheses, relationships should not be diligently sought. It *is* being argued that non-theoretical description—"mere description"—is respectable because it may well be the ultimate "truth"; and it tends to keep us honest in our theorizing.

LESTER E. KLIMM

ECONOMIC GEOGRAPHY

VOL. 35 JANUARY, 1959 NO. 1

LAND USE WITHIN THE EUROPEAN COMMON MARKET

S. Van Valkenburg

Dr. Van Valkenburg is Director of the Graduate School of Geography, Clark University.

ALTHOUGH the accepted plan for the European Common Market envisages freedom of exchange of agrarian products, it will be many years before that will become reality. The difficulty is not only one of adjustment of the pattern of land use to such a free trade region. To a large extent the problem is how to unite the economies of the member nations, since these nations vary greatly with regard to production costs, consumption prices, and government protection and help.

One of the first steps towards a comprehensive understanding of the problem is an inventory of the present conditions. This study is an effort to start such an inventory. With limited field time available (the author spent the second part of 1957 in Europe) and also because of the size and complexity of the problem, this article is in general terms. But it may suffice to convince the reader that it is not a simple process to develop economic unity and that it will take a long period of planning before that unity can function effectively. The basis of this study is a map of standards of land use (Fig. 1). Besides the map there are several statistical tables which provide information. A brief description of the map is necessary before evaluation of the land use of the individual nations can be attempted.

GENERAL REMARKS

The purpose of the map is to give a general picture of the standards of land use within the "Common Market." The key is kept simple. The areas of the first two categories are subdivided in regions of a certain degree of agrarian uniformity. The boundaries are agrarian and not political. The third category—the mountains—is left undivided.

The map is based on statistics, on literature, and on personal observations. Most of the areas are known to the author. The chief criteria used were the yield of crops per hectare, the importance of livestock for meat and dairy produce—with special reference to the amount of milk per cow, and the value of production expressed in local currency. For France, the degree of intensity of production, as introduced by Joseph Klatzman, and for Germany the assessed value of farm land, were used. For Italy, the map has been checked by Professor Giuseppe Orlando, Director of the Istituto Nazionale di Economia Agraria at Rome; for Germany, by Dr. Heinrich Niehaus, Director of the Institut für Agrarpolitik und Marktforschung der Universität

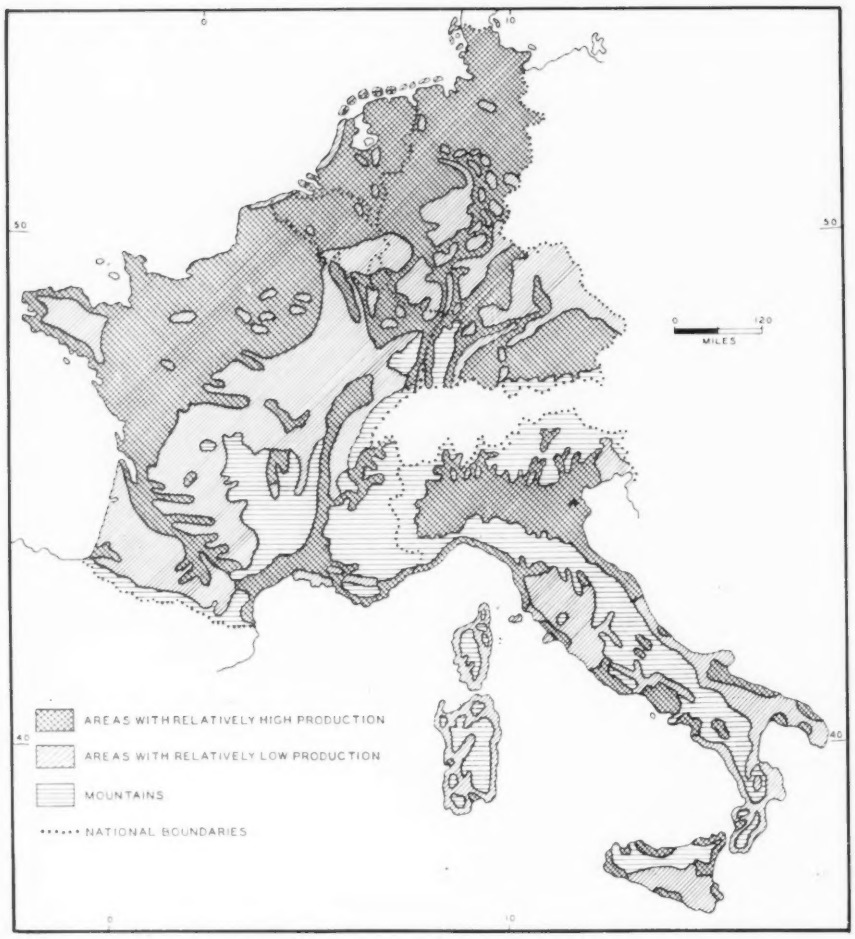

FIG. 1. Standards of land use in European Common Market countries.

Bonn; while for France the author had the cooperation of the faculty of the Institut de Géographie of the Sorbonne in Paris. The author wishes to express his deep gratitude for this assistance. He alone, however, assumes responsibility for the map.

AREAS OF RELATIVELY HIGH PRODUCTIVITY

Selection of the areas of relatively high productivity is based on various measures, for instance a wheat production not below 25 quintals per hectare, milk production per cow not below 2000 liters, and a production value per hectare of arable land not below the local equivalent of 300 dollars. At times, with low yields and low milk production, the production value is still high because of special crops of high value, such as grapes, citrus fruit, vegetables, or flowers. In other instances, the import of fodder for live-

stock increases the output in spite of the relatively low productive value of the land itself.

An important feature not included in the criteria for assessment is the actual cost of production. Except for specialties, agrarian production within the "Common Market" does not pay for itself but has to be supported. This can be done through financial help given directly to the farmer, thus permitting a lower price for the home consumer as well as for export markets. Another method is protection by way of tariff which prevents competition from abroad. Contingents (or quotas) also can be used. Reasons for the high cost price are not hard to find. Soils, functionally poor, may have to be heavily fertilized, drainage or irrigation may be necessary, and, at times, the national economy may need the home production of a certain crop in spite of unfavorable conditions.

AREAS OF RELATIVELY LOW PRODUCTIVITY

The areas of relatively low productivity are not all problem children. Some of them are valuable for recreation; others with a forest cover are, for that reason, valuable assets in the national economy. Still others provide grazing for livestock later transported to other regions for fattening.

But, as a rule, yields are low, livestock is inferior, and the farmer is poor. There are many reasons for low production. Soils may be of low fertility. The climate may be too wet; in other localities it may be too dry or with too short a growing season. There may be serious soil erosion. Big land holdings may be under absentee or disinterested landlords; on the other hand, properties may be too small for efficient production. Health conditions are perhaps poor and capital may be lacking. The attraction of better opportunities elsewhere often causes depopulation, and the land is consequently left uncultivated.

Much has been done to improve conditions. Drainage of marshes, irrigation, use of fertilizers, redistribution of land, better education, and better housing can do a great deal, although the costs may be extravagant. It will undoubtedly be possible to decrease the areas of low productivity if the emphasis is not on the costs of produc-

TABLE I

IMPORTANCE OF AGRICULTURE IN THE COMMON MARKET

1956

Country	*Percentage of actual engaged population*	*Percentage of gross national product*	*Percentage of imports*	*Percentage of exports*	*Difference in millions of dollars*	*Agricultural imports*		*Agricultural exports*	
						millions of dollars	*Per capita*	*millions of dollars*	*Per capita*
France	27	16	20	10	−630	1095	25	465	11
West Germany	16	10	26	2	−1590	1745	34	155	3
Italy	36.4	26	14.5	20	−20	460	10	440	9
Belgium	12	6.67	13	3.5	−309	433	48	124	13
Luxembourg	26	9							
Netherlands	13	10.5	13.5	30	+328	500	45	828	75
Common Market	28	15	21	9	−2221	4233	26	2012	12.5

Data from Agricultural and Food Statistics, OEEC, Paris, 1956.

tion. However, there will remain areas for which little can be done. The only solution would be to remove the farmers and to reforest the area if possible. But this is a social problem which involves difficulties, and in many instances the government may prefer subsidies in order to avoid discontent.

Mountain Areas

Areas are defined as mountains as a result of elevation and relief. Generally, they have little value and show great complexity in land use. Valleys may be in crops or grass, slopes forested, and the high pasture used for summer grazing. However, in general, the farmer has a difficult existence. At present many people, especially the young men, leave for the more attractive lowlands or go to factories; the fields are abandoned, villages depopulated, and only the forest remains.

The Overall Picture of Food Supplies

The productivity of the land is of vital importance to the nations of the Common Market (Table I), even if in expressed value it has been surpassed by industrial production. Although the proportion of actively engaged population involved in agriculture has been steadily declining, it still occupies 28 per cent of these people, with a high in Italy (36.4 per cent) and a low in Belgium (12 per cent). The share of agriculture in the gross National Product is, however, only a little more than one-half of the percentage of total agrarian workers, which indicates the chief problem of the farmer, namely, insufficient income. The relation between percentage of population and percentage of the National Product is best for the Netherlands (13 and 10½ per cent) and worst for Luxembourg where 26 per cent of the population

TABLE II

LAND USE WITHIN THE COMMON MARKET, 1956

Equivalent of one per cent		*In percentages of total for group*				
		France	*West Germany*	*Italy*	*Belgium-Luxembourg*	*Netherlands*
1.7 Million	Population	27.8	31.3	30.1	5.8	6.9
1,165,000 hectares	Area	47.2	21.0	25.9	2.9	3.0
470,000 hectares	Arable	44	18	33	2	2
250,000 hectares	Grass	49	22	20	3	5
150,000 hectares	Forest	44	28	23	3	1
106,880 hectares	Wheat (area)	41	10	46	2	1
217,370 tons	Wheat (prod.)	45	14	37	2.5	1.5
22,750 hectares	Rye (area)	18	68	4	4	7
55,970 tons	Rye (prod.)	10	74	2	6	9
38,620 hectares	Oats (area)	56	24	12	4	4
75,440 tons	Oats (prod.)	48	33	8	6	6
23,560 hectares	Barley (area)	52	31	10	3	3
51,870 tons	Barley (prod.)	49	36	5	5	4
9,820 hectares	Sugar (area)	38	25	22	6	8
56,580 tons	Sugar (prod.)	36	28	19	7	9
28,100 hectares	Potatoes (area)	34	42	14	4	6
727,180 tons	Potatoes (prod.)	30	50	6	5	8
430,000	Cattle	36	33	19	5	6
268,400	Pigs	27	46	14	5	7
19,450	Sheep	40	7	51	1	2
14,140 tons	Eggs	29	24	32	4	7
535,000 tons	Milk	39	35	8	7	11
52,000 tons	Meat	36	37	11	7	8

Data from Agricultural and Food Statistics, OEEC, Paris, 1956, and other sources.

produces only 9 per cent of the National Product.

Also significant is the relative importance of foreign trade in agricultural products (this includes, besides food, such items as tobacco and cotton). Except for the Netherlands all nations of the Common Market have a deficit. Western Germany is most badly placed. However, calculated on a per capita basis the deficit for Belgium is even higher. In both cases the reason for this is the relatively small value of the domestic agricultural products. The import value for the Netherlands, when calculated per capita, is almost as high as that of Belgium, but this is more than balanced by the much higher exports. The trade value for Italy is quite low and the deficit is rather small. This, however, is based on a rather low standard of life.

The overall deficit for the Common Market in 1955 was about 2½ billion dollars; in 1956 this had declined to 2.2 billion. But even the lower amount is high enough to play an important part in the planning of the future.

LAND USE OF THE INDIVIDUAL COUNTRIES

It is of interest to consider the variations in land use country by country.

France

France has an excellent position from the agrarian point of view. This is clear if Table II is studied. For a population which is 27.8 per cent of the total population of the members of the Common Market, France has 44 per cent of the arable land and 49 per cent of the grassland. Production of the major crops expressed in percentages of the Common Market total is well above the percentage of population; the only exception is rye, which is of minor significance in France. A somewhat disturbing factor is that, except for wheat, percentages of area are higher than those of production, indicating that the standard does not reach the average of the Common Market. Livestock, expressed in numbers and in production (meat, milk), is in a strong position, except for pigs where the percentage is slightly lower. But again, if expressed in milk per cow, the standard of French dairying is well below that of the three northern members (it is only slightly more than one-half that of the Netherlands, the ranking dairy country), and only Italy is lower. Table III also shows the strong general position of France; there are few deficits, the only real one being

TABLE III

SELF-SUFFICIENCY (PERCENTAGE)

1956

	France	*Germany*	*Italy*	*Belgium-Luxembourg*	*Netherlands*
bread grain	126	77	93	61	45
coarse grain	94	73	95	46	39
rice	68	...	149	...	...
potatoes	102	99	100	96	146
sugar	127	85	99	136	92
vegetables	98	82	112	100	146
fruit	64	50	129	80	87
meat	102	93	90	96	132
eggs	96	62	92	102	238
fish	94	96	64	65	213
cheese	102	81	99	37	210
butter	103	93	92	94	226
other fats	54	29	69	25	38

Data from OEEC.

TABLE IV

CONSUMPTION PER CAPITA (KG)

1956

	France	*Germany*	*Italy*	*Belgium-Luxembourg*	*Netherlands*
bread grain	104.0	92	123.8	98.5	85.7
coarse grain	2.8	2.9	16.9	4.2	3.6
rice	1.8	1.5	6.5	1.1	2.7
potatoes	135.4	158.0	49.0	151.0	107.0
sugar	27.6	27.4	17.1	27.6	41.2
vegetables	143.8	48.0	93.7	65.3	66.6
fruit	46.9	62.8	69.7	84.8	49.6
meat	77.6	47.4	20.2	51.3	38.4
eggs	11.0	10.2	7.6	14.2	8.3
fish	9.4	7.4	7.0	12.0	8.1
milk	88.7	124.9	53.2	94.8	197.6
cheese	7.1	6.1	6.9	5.7	6.4
butter	5.5	6.5	1.3	9.3	2.6
other fats	6.3	19.3	11.2	13.0	25.3
Calories	2830	2970	2560	2990	2970

Data from OEEC.

the lack of fats. Much of its needs, however, can be supplied by French tropical Africa. Moreover, there is in normal years a good surplus of wheat. Consumption (Table IV) is remarkably high in meat—almost as high as that of the United States—and vegetables; the only low spot is the home consumption of milk. The index of production (Table V) shows an increase in all items, except potatoes. Taken as a whole, France produced 98 per cent of her food consumption, the same as Italy but with a much higher standard of life. Corresponding figures for Germany and Belgium are 74 per cent and 70 per cent.

THE STANDARD OF LAND USE

As the map indicates (Fig. 1), France has a considerable share of the large high standard area which starts at the Gironde, runs through northern France, Belgium, and the Netherlands and continues through northern Germany. This continuous area is, however, far from uniform in its land use and has to be subdivided into regions of relative uniformity. Such is also the case in the French part. Continuous on the map, but for a few areas of lower productivity—interior Brittany, the hills of La Perche, and the forested section in the northern plain—it falls into two major subdivisions, separated by a line running southward from Dieppe on the British Channel. To the east of that line cropland prevails; to the west, grass. In both instances there is a decline in productivity from north to south.

Northern France

The northern crop area is the best agricultural region of France. A good example is furnished by the Department Aisne in the north of France (agricultural statistics in France are given by departments). This lies within Region 49, Figure 2. Of an area of 742,835 hectares, 50.5 per cent is in crops, 20.6 per cent in grass, and 16.2 per cent in forest. Yields of wheat, the major grain crop, are high (1954: 36.9 quintals per hectare). It is the chief sugar beet area of France, with 56,000 hectares. There are 258,000 cows, of which 117,000 dairy cows have a milk production of 2520 liters per cow; also 58,000 pigs and 88,000 sheep. Although

TABLE V

INDEX OF PRODUCTION, 1956 (PREWAR 100)

	France	*Germany*	*Italy*	*Belgium-Luxembourg*	*Netherlands*
bread grain	120	124	130	110	84
coarse grain	113	113	106	119	209
rice	...	...	114	...	...
potatoes	97	117	120	94	133
sugar	162	233	337	168	185
vegetables	103	109	171	117	119
fruit	177	118	173	214	193
meat	138	122	109	123	154
eggs	118	124	109	123	171
fish	112	123	120	171	149
milk	124	112	139	121	113
cheese	121	172	134	167	139
butter	137	110	122	136	72
other fats	185	135	76	129	193

Data from OEEC.

the loessal soils are excellent the use of fertilizers is the highest in France, as is the use of mechanical equipment. The value of crops alone was 54 billion francs in 1954. Properties are rather large.

The decline southward is illustrated by similar statistics for the department Eure et Loire south of Paris (southern part of Region 49). The area of 593,980 hectares has 73.7 per cent in cropland, 7.7 per cent in grass, and 11 per cent in forest. The yield of wheat, by far the major crop, is 31.2 quintals per hectare. The number of livestock (cattle and pigs) is much smaller, but there are 196,000 sheep. The use of fertilizers is less than one-half of that in Aisne, while the use of mechanical equipment is also less.

Within this cropland region of Northern France are two special areas: the dairy region of Braye with its clay soils and the hills of Boulonnais with their more mixed type of land use.

A typical example of the grassland region is the Department Manche on the Cotentin Peninsula (Region 50). Here on an area of 641,168 hectares, only 14.9 per cent is in crops but 63.7 per cent in grass; there is little forest but many trees (bocage). Cattle number 572,000 of which there are 320,000 dairy cows with an average milk production of 2608 liters per cow. Fruits do well, especially apples, the source of French cider. Here again is a decline to the south and forage crops partly replace grass. Charente Maritime south of the Vendée (Region 61) still specializes in dairying, but the number of cows is only 241,000, of which there are 143,000 dairy cows with a milk production of 2097 liters per cow. Grain yields are low (wheat 22 quintals). We have come here to the limit of the top category.

The coasts of Brittany (Regions 58 and 59) are noted for their vegetables and fruit, especially early crops for the Paris Market or for export. The Loire valley with its cultivated valley floor and its vineyards on the slopes is also a separate unit.

Eastern France

The escarpment landscape between the Paris Basin and the Vosges Mountains shows a series of regions running north-south in a kind of half-moon shape. The standard of land use of those regions varies greatly due to soil conditions. As the political structure does not correspond to this zonal

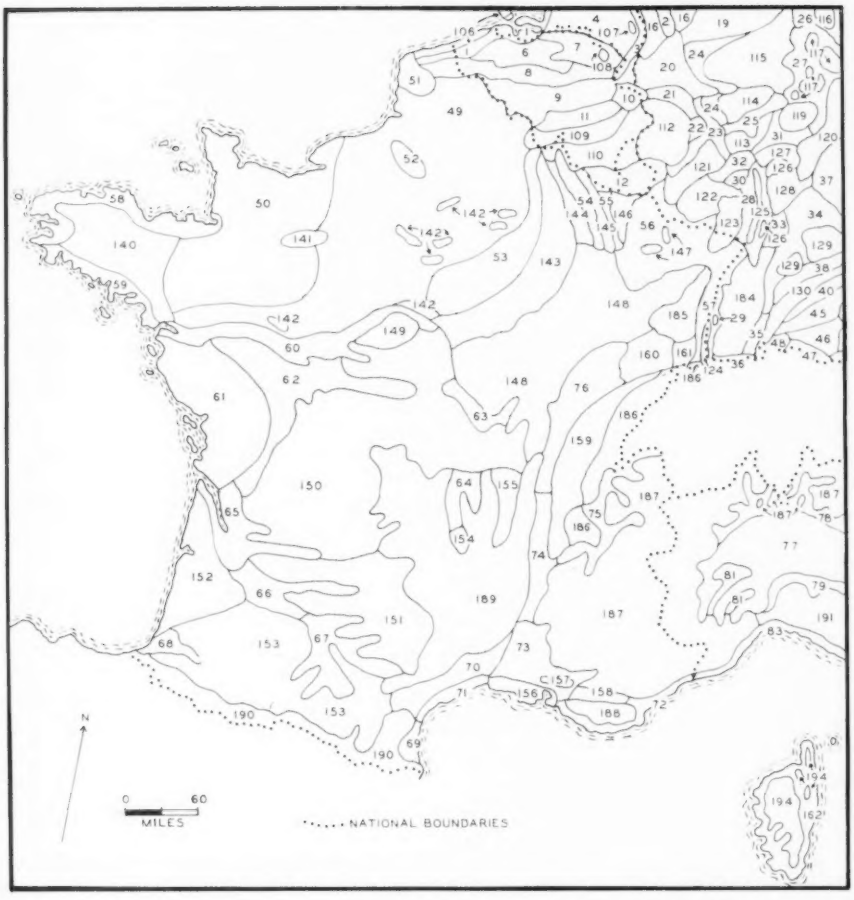

FIG. 2. Identification map showing productivity regions of France and neighboring areas in Common Market. For names of regions see Appendix.

development no clear test cases can be given.

Starting from the west the Dry Champagne (Champagne Pouilleuse, Region 53) is still wheat land, yielding 27.9 quintals, but yields are lower than those of the adjacent area of the plain. This area includes the famous Reims wine districts which increases the value of the land use. The next zone, the Wet Champagne (Champagne Humide, Region 143), is less productive; grass and forests prevail and the standard of land use is low. The three lines of escarpment—Argonne Forest, Côte de Meuse, Côte de Moselle—(Regions 144–146) are also forested. Between them are better areas: the Valley of the Meuse, the Woëvre Plain, and the Lorraine Plain (Regions 54–56). In general the type of land use is that of mixed farming, crops, livestock, and fruit. The statistics of the Department Moselle illustrate this rather well. On

an area of 625,290 hectares, cropland covers 31 per cent, grass 30 per cent, and forests 25.5 per cent. Wheat and oats are about equal in importance; the yield of wheat is 22 quintals which is an average between better plains and inferior escarpment hills. There are 231,000 cattle of which there are 141,000 dairy cows (milk yield 2186 liters), 191,000 pigs, and 78,000 sheep. Forage crops prevail.

The Rhine Valley

The French share of the Rhine Valley (Region 57) has a high standard of land use similar to the German section across the Rhine and to the north. The only exception is the southern part (Sundgau) where soil conditions are poor. Of the Department Bas Rhin 31.6 per cent is in crop, 20 per cent in grass, and 33.3 in forest (Vosges Mountains). Yield of wheat is 27.9 quintals per hectare. There are 185,000 cattle of which 115,000 are dairy cows with an average yield of milk of 2049 liters. Specialties which increase the land use value are the vineyards on the lower slopes of the Vosges, hops for beer production, and tobacco.

The Saône-Rhône Landscape

The Saône-Rhône Valley (Regions 74–76) is well cultivated; moreover, the western slopes are famous for vineyards (Burgundy) with a total wine value of 13 billion francs. Typical of the land use pattern is the rather small Department Rhône. Of the 285,934 hectares, 23.1 per cent is in cropland, 28.8 in grass, and 14.6 in forest. Yields of wheat are rather low (18 quintals per hectare) but the yield of milk of the 67,000 dairy cattle is 2441 liters per cow. The Jura foreland and plateau (Regions 159 and 186) to the east specialize in dairying, with high yields of milk per cow, 2760 liters for Department Jura and even 3037 for Doubs. But the number is not large enough (Jura, 70,000; Doubs 84,500) to put the region in the higher category. Forests cover large areas and there is little cropland.

It was, however, possible to include the northern valleys of the Alps in the high category. The agrarian economy is similar to that of many valleys in Switzerland with much fruit and vegetables. The chief emphasis is on dairying. Department Haute Savoy (Region 75) has 68,800 dairy cows with a yield of 2663 liters of milk per cow. In the Alps to the south, where climatic conditions are less favorable, the standard of land use is much lower and also the number of cattle decreases.

The Garonne Basin

The large area between the Pyrenees and the Central Plateau offers considerable variety of land use but the standard is rather low except for the valleys themselves. Typical, for instance, is the yield of wheat of the Department Gers (Gascogne, Region 153) which is only 16.5 quintals, while the yield of milk per cow is only 962 liters. Besides wheat, corn also is important. It is, however, the wine production which puts the valley and adjacent slopes into the high category. The total value of wine production in the Departments involved, Dordogne, Gironde, Lot et Garonne, and Tarn et Garonne (Regions 65–67) was about 50 billion francs in 1954.

The coastal zone along the Gulf of Biscay and inwards is called "les Landes" (Region 152). Pine forest covers 60 per cent of the area which is the chief supply for softwood and turpentine in France, but the value is not high enough to put it in the top category.

The Central Plateau and Its Northern Foreland

Most of the Central Plateau is a high upland (Region 189). In the northern part (Cantal, Puy de Dôme) grass prevails. There are large numbers of cattle, which are often sent to other regions for fattening purposes. In the southern part, sheep replace cattle on the limestone plateaus (Les Causses, Region 151). The department of Aveyron, for instance, has 454,000 sheep. But the crop yields are very low and the farming population is poor, a lot of arable land is left uncultivated, and whole villages are abandoned.

Much better are the valleys which penetrate from the north (Loire, Allier) and the west (Lot, Dordogne, Tarn). If not in canyon form (Gorge du Tarn) they are well cultivated. The largest valley is that of the Allier, the so-called Limagne (Region 64). Here, however, agrarian depopulation has set in and the high category ranking may be somewhat optimistic.

The northern foreland (Region 150) belongs generally to the category of relatively low production. This comes somewhat as a surprise as the area gives an impression of being well cultivated. The Department of Cher, size 730,353 hectares, has 46.5 per cent in crop, 18.2 per cent in grass, and 20 per cent forested; for neighboring Creuse the corresponding figures are 42.5, 25.7, and 9.9. Yields of wheat are low (17–18 quintals). Cher has 187,000 cows of which 83,000 are dairy cows with a yield of milk of 1938 liters per cow; Creuse has 250,000 cows of which 132,000 are for dairy purposes, but the milk yield is only 1520 liters. One wonders whether with better methods better results could be obtained. South of the Loire bend is the Sologne, a somewhat neglected wooded area on sandy soils.

The Mediterranean Coastal Zone

The reason that the coastal zone of the Mediterranean (Regions 71–73) is included in the high category is the importance of special crops, such as wine, fruits, vegetables, and, in the eastern part, flowers. Yields of wheat are low (Herault, for instance, 13.5 quintals); cows are few being outnumbered by sheep. But values for wine are very high, for example, 13 billion francs for Pyrenees Orientale (Roussilon) and even 30.6 billion for Herault (Midi). Vaucluse is famous for its early vegetables and fruit; the eastern Riviera, around Grasse, for its flowers. Cultivation has improved in the upper Rhône delta but the lower part (Camarque) is still of low value. Important here is the increase of rice production which, for the Department Bouches-du-Rhône, amounts to 375,000 quintals (on 13,800 hectares), giving France in good years a surplus, partly because of low home consumption. The combination of Mediterranean fruits and vegetables continues along the Rhône Valley to about Valence.

Corsica

Corsica (Region 162) is a sad story. Only 1 per cent is in crops; grass covers 29.1 per cent; forest, 20.7 per cent; the rest is wasteland. Yields are very low (wheat 12 quintals per acre). There are few cattle and the yield of milk per cow is only 382 liters; sheep are numerous, however (229,000). Typical are the chestnuts which are important in the food supply.

France as a Whole

The role of France as an agrarian producer within the Common Market, important as it is already, could be greatly improved. But for the northern parts with their relatively large proper-

ties, intensive use of fertilizers and machinery, and high yields for crops and livestock, the greater part of the rest of France has almost antiquated conditions. Properties are small and broken up in still smaller sections, often at considerable distance from each other. Such fragmentation does not permit the use of machinery. Yields are often unnecessarily low; the farmer is poor and cannot spend much capital on fertilizers. In despair the farmer leaves his land for the industrial cities and the percentage of uncultivated arable land is high. Farmers brought in from the Netherlands have shown what could be accomplished. What is needed is a careful, detailed study of the areas of the lower category in order to see whether they are worth saving for agriculture or should be utilized in other ways, for instance left to forest. French agriculture south of the Loire, except for specialties, has declined in value. There have been plans for improvement, such as the Monnet plan, but not enough has been done. The impact of agrarian free trade within the Common Market can only be met by a great effort to modernize French agriculture. France has all the requisites of a prosperous agrarian economy which can provide surpluses (especially the much needed wheat) for the other member nations.

Italy

The position of agriculture in Italy is different from that in the other member countries of the Common Market. First of all the proportion of the actively engaged population involved in agriculture is about 36.4 per cent, the highest in Europe. In southern Italy this percentage is well above 50, with the highest percentage (73) in the Bassilicata. The income derived from total land use is 26 per cent of the national income, also the highest within the Common Market. Another outstanding fact is that only 33 per cent of the income is from livestock, compared with 63 per cent for Belgium and 70 per cent for both the Netherlands and Germany. Of the total value of crop production 37.6 per cent is from cereals, 30.6 per cent from fruit and vegetables (remarkably high), and 15 per cent from wine.[1]

TABLE VI

PERCENTAGE OF SELF-SUFFICIENCY, ITALY

	1948–49	1959
Wheat	37	54
Rye	94	98
Secondary Grains	65	73
Potatoes	99	99
Sugar	57	85
Vegetables	92	82
Fruit	...	50
Meat	93	93
Milk	100	100
Cheese	94	81
Eggs	86	62
Butter	100	93
Fats	59	29

Data from OEEC.

Table II shows the general picture of Italian land use. Surprisingly, the percentage of arable land is higher than the population percentage but a large part of this arable land is of inferior value. There is quite a discrepancy between percentages of area and of production, indicating the low average yields. This low average is even more disturbing if one considers the high yields in Northern Italy. In Lombardia (Region 77 and 79), for instance, the yield of wheat per hectare is 33.2 quintals and in Sicilia (Region 181) only 7.4 quintals (Fig. 3). The major crop is wheat but high consumption still causes a deficit.

[1] Agricultural exports have a value of 24.3 per cent of the total exports (second highest after the Netherlands), while agricultural imports have a value of 21 per cent of the total. Due to the higher value of gross imports, however, the agricultural imports exceed the agricultural exports in value. Thus Italy still has a deficit in agricultural trade.

The consumption of fruit and vegetables is high, but low to very low are sugar, meat, eggs, butter, and milk.

The degree of self-sufficiency is rather high and at first glance gives the impression that agricultural production is well adjusted to consumption. In reality it is the other way around and the self-sufficiency is based on a low consumption of sugar, meat, eggs, and butter. The consumption of wheat is the highest of any of the nations of the Common Market and the production is not high enough for consumption. Production increases, if compared with those of prewar periods, are encouraging, but one has to take into consideration that the same index for population is 115.

Italian Land Use

Italy is generally regarded as the weakest member of the Common Market, seen from the agrarian point of view. Such a statement, however, is only true for Central and Southern Italy as Northern Italy is at par with the best areas of the other nations. In Central and Southern Italy yields are generally low and the peasant is poor—in many cases, very poor. There are many reasons for that. Along the peninsula and on the islands, mountains and uplands prevail while the suitable land is often limited to narrow coastal plains and coastal hills as well as river valleys. The precipitation is one of heavy showers in winter—often causing landslides on the deforested slopes—and a long, dry summer season. Irrigation is possible only if the winter water supply is stored in reservoirs. Occasional invasion of cold air masses in winter causes damage to the crops (olive trees, citrus, early vegetables). Soils used for centuries need fertilization and the farmer himself lacks the knowledge of how to improve his land use. Until recently malaria ruled many of the coastal plains. The system of large landholding, dating back from ancient times, gave no incentive to the peasant to improve his conditions; moreover, landlords were often absent.

But there is also another side to this grim story. Much has been done to improve conditions and as the map indicates there are many sections where the standard of land use has reached a level high enough to be included in the class of relatively high production. On the map they appear spotty, but the encouraging fact is that the spots are increasing in size and in number. Some of them have been in existence a very long time—parts of the Arno Basin (Region 84), the fertile Campania around Napoli (Region 93), the Bari plain in Pulia (Region 97), and the coastal sections of Sicily (Regions 100–102).

Others are the result of improvements made during the last decades and especially after the last war, the work of the well-known Cassa per el Mezzogiozno. The Pontine Marshes (Region 86) have been transformed into productive farmland (prewar), the once malaria infested Maremma is now dotted with small farms, and the central section around Grosseto has already reached the higher level of production. Others include the reclaimed lake of Fucino (Region 91) in the Central Apennines, the Tavoliere around Foggia (Region 56), and the plain of the Volturno-Garigliano (Region 92). Improvements are made in Calabria, Sicily (especially the plain of Catania), and in Sardinia. Altogether, about 260,000 acres have been developed, partly through drainage and irrigation. Dams have been built to store the water in reservoirs; aqueducts have been constructed. But the costs are heavy and Italy will look toward the other member nations of the Common Market for financial help. Improvement of the

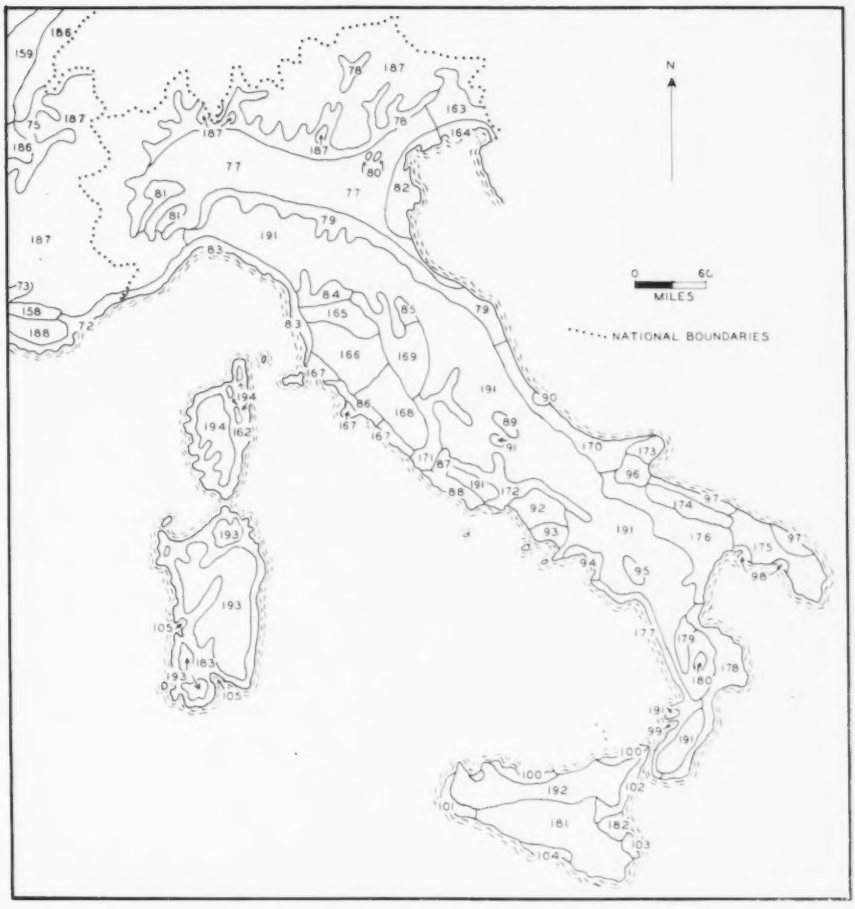

FIG. 3. Identification map showing productivity regions of Italy and neighboring areasin Common Market. For names of regions see Appendix.

land is not enough. What is needed is a long period of farm education, the introduction of mixed farming, better roads, and better housing. Here is fertile ground for constructive work.

The North Italian Plain

The North Italian Plain (Regions 77–80), with the adjacent hills and lower valleys of the Alps and Apennines, is by far the most productive region of Italy. The crops on the plain, with their high yields, the high value of livestock, and the profusion of fruits and vegetables (including grapes for wine) on the hills have given this area one of Europe's most productive agrarian economies. The four areas—Piemonte, Lombardia, Veneto, Emilia (representing 30 per cent of the territory of Italy)—produce 43.3 per cent of total Italian agricultural production expressed in value, 38 per cent of the crop value, 52.6 per cent of the live-

stock, and 26.9 per cent of the value of Italian forestry. This is even more remarkable considering the fact that an important part consists of relatively unproductive mountains. For the chief crops the four units produce 47 per cent of the wheat, almost 80 per cent of the corn, practically all the rice, and 83 per cent of the sugar beets (expressed in value). For cow milk the percentage of the total is 75 and even for fruit, vegetables, and wine, for which other parts of Italy are also famous, the percentages are respectable (vegetables, 30; fruit, 35; wine, 35). The alluvial soils with the help of heavy use of fertilizers give high yields, much above the Italian level. This is shown, for instance, by the fact that in the four areas mentioned above the wheat area is 27 per cent of the Italian total while the production is 47 per cent. The introduction of hybrid corn (now used on 24 per cent of the corn area) increased the production since 1948 by 6 million quintals. Quite important has been the increase of beet sugar production (principally in Emilia and Veneto), an increase from 400 thousand metric tons in the prewar period to 1089 thousand tons in 1955, based partly on an increase in acreage but chiefly on higher sugar yields of the beets and better production methods. Hemp, one of the specialties of Northern Italy, has declined to one-third of the prewar production.

The Role of Italy within the Common Market

Italy, thanks to a different climate, will be quite an asset to the Common Market, especially because of the fruits and vegetables, many of them early on the market (primeurs). This export will increase if better transportation methods become available. Italy is well under way to becoming for the Common Market what Florida and Southern California are for the United States. Increases in export of corn and rice seem also to be possible if the present trend continues and the European consumer becomes more conscious of rice as food. There has been a substantial increase in wheat production which will continue if more of the South is improved; however, the cost of production is high. A weak spot is the decrease of olive oil production, to a large extent based on bad winters. During the period 1948–55 olive oil production declined from 2,072,000 quintals to 1,700,000 quintals, which resulted in a large deficit. The export of wine, however, is increasing. Italy is now the largest producer of wine in the world, having bypassed France in recent years.

Altogether it seems quite possible that the now balanced trade of food (values of imports and exports are about the same) will change into one of surplus of export values.

Germany

The problem of Germany is to provide from a relatively small area as much home produced food as possible in order to feed her large population which has a rather high standard of life. Table II shows that percentage of cropland and grassland are well below the percentage of population and even high yields cannot make up for this. The results have been quite remarkable as the percentages of production are generally equal or above the percentage of population. Only in wheat is the percentage figure low.

Comparison between consumption in 1948–1949 and in 1956 is rather interesting. In spite of higher production, percentages of self-sufficiency have generally declined because of the higher consumption especially of dairy

products, eggs, and meat. The increase in percentage of self-sufficiency of sugar is based, however, on an astonishing increase in beet sugar production; the acreage has more than doubled if compared with prewar conditions and the production increased from 553,000 tons, average 1934–1938 to 1,439,000 tons in 1955–1956.

The Land Use of Germany

General agricultural statistics on Germany are available only by individual provinces (Länder) which are not uniform in their agrarian structure and are also rather unequal in size. Table VII gives, nevertheless, a general picture of distribution of agrarian production expressed in percentages which can be compared with the percentage of size. The distribution of cropland is almost the same as the areal size expressed in percentages. Grassland dominates in the South. The prevalence of rye in the North is clearly shown, as is that of wheat in the South. Potatoes and sugar beets are most important on the northern lowland, especially in the eastern section. There is a strong correlation between these two and the distribution of pigs. Horticulture is most significant around the large industrial cities of the lower Rhine (Ruhr area).

The map of standards of agrarian production shows the importance of the northern lowlands and of the Bavarian Plateau while the area between is broken up into productive valleys or basins, separated by less productive uplands (Fig. 1). In fact the map resembles strongly a map of morphological regions.

The northern lowlands have a zonal structure from the point of view of land use: the immediate coastal zone of sea clay and dairying (Region 13); the wide zone of sand and moors (Regions 16 and 17), now generally under cultivation although some waste land is still left; and the southern piedmont zone of high fertility (Regions 18 and 19) (Fig. 4). In Schleswig Holstein the first two are continued, running south-north, but in the east is a region of glacial loam (Region 15).

The northern part is the heartland of German agriculture, with a high level of production. Here the crops of rye, potatoes, and sugar beets are produced; here is also the center of dairy and meat production with a second center on the Bavarian Plateau. The Bavarian Plateau can also be divided roughly in two parts—the southern dairy zone and the northern crop zone with wheat and specialties such as hops.

The intermediate zone of valleys and basins is typically used for mixed agriculture: crops, livestock, and fruits. Along the Mosel and the Rhine-Neckar are the vineyards producing the well-known German wines. Each area has its own characteristics, but space does not permit a description. Areas of a low standard of production generally correspond to the uplands, where soils are poor and shallow, and forest generally does better than cropland; the names of these uplands are given in the name list of the individual regions (see Appendix).

There are, however, some discrepancies. In the otherwise quite productive Upper Rhine Valley are some sandy areas of low fertility as well as sections of the flood plain of the Rhine River (Regions 124–126). Much larger is the area between the upper Main and the Danube (Middle and Upper Franconia and Upper Pfalz, Regions 134 and 135) which are noted for infertile sandy soils and low productivity.

TABLE VII

STRUCTURE OF LAND USE IN GERMANY, 1956

	Percentages of total							*Total Western Germany Areas in thousands of hectares*
	Schleswig-Holstein	*Niedersachsen*	*Nordrhein-Westfalen*	*Hessien*	*Rheinland-Pfalz*	*Baden Wurtemberg*	*Bayern*	
Total Area	8.0	20.0	14.0	7.3	7.0	14.0	28.0	24.427
Cropland	8.2	18.9	14.9	8.4	7.8	13.3	28.2	8,092
Horticulture	9.0	21.0	25.6	8.3	6.7	10.1	15.0	566
Grass	8.5	23.0	13.2	5.7	5.3	14.5	29.3	5,542
Forest	1.9	12.8	11.7	12.0	10.5	18.0	32.7	6,921
Wheat	5.4	12.2	14.0	9.0	6.3	24.0	33.3	1,155
Rye	8.3	27.7	17.6	9.3	6.6	3.7	26.3	1,394
Barley	4.3	9.0	11.3	5.1	9.0	18.0	43.2	788
Oats	7.2	22.0	15.2	10.8	10.0	9.5	26.0	1,054
Potatoes	5.3	24.0	14.8	8.9	12.3	13.2	27.2	1,164
Sugar beets	5.2	43.4	19.3	7.0	5.7	6.1	9.2	228
Cattle	9.0	19.3	13.1	6.7	6.2	13.6	31.1	11,521
Pigs	8.2	28.7	18.0	7.9	5.0	14.0	21.1	14,525
Sheep	9.3	22.6	14.8	11.5	4.3	14.6	23.0	1,225
Chickens	6.9	19.3	21.9	8.0	6.5	13.1	23.0	55,091

The two city states, Hamburg and Bremen, are not included.
Grassland includes a great variety of grass value from the almost cultivated grasslands of the North Sea Marshes to the rough Alpine meadows.
Data from German sources.

The German Agrarian Economy

A study of the tables gives a good picture of German agriculture. The percentage of people engaged in agriculture is fairly high, but the share in the gross national product is only 10 per cent. In spite of having only 18 per cent of the Common Market's cropland, the country's production percentages (except for wheat) are much higher and the difference between area and production expressed in percentage indicates the high yields. Germany is also doing very well in livestock, especially in pigs. The table of self-sufficiency indicates, however, that even the high standard of production cannot offset the scarcity of land, and Germany is deficient in all the items mentioned on the table, even in sugar in spite of the large increase. Rising consumption in a prosperous Germany will increase the demand for meat, dairy products, fruits, and vegetables and this deficit may even increase. There is an overall increase of production as indicated in Table V, but the increase of population since 1939 has been almost 30 per cent, chiefly the result of the influx of refugees. The deficit of food is by far the highest of the members of the Common Market. There will be some increase of production in the better areas and some increase of productive land in the sand-moor lands in the northern plain. But most of the area of low production will remain inferior; in some cases forests may replace the now low yielding cropped fields. Unlike France and Italy there is not much hope for a better situation in the future; Germany will remain a large deficit country.

Belgium-Luxembourg

In contrast to the Netherlands, Belgium-Luxembourg has a large area of relatively low productivity, namely the Ardennes uplands. But the rest is highly productive. Crop yields are among the highest of the world. The number of cattle per unit of arable land is even larger than in the Netherlands, although the total number is

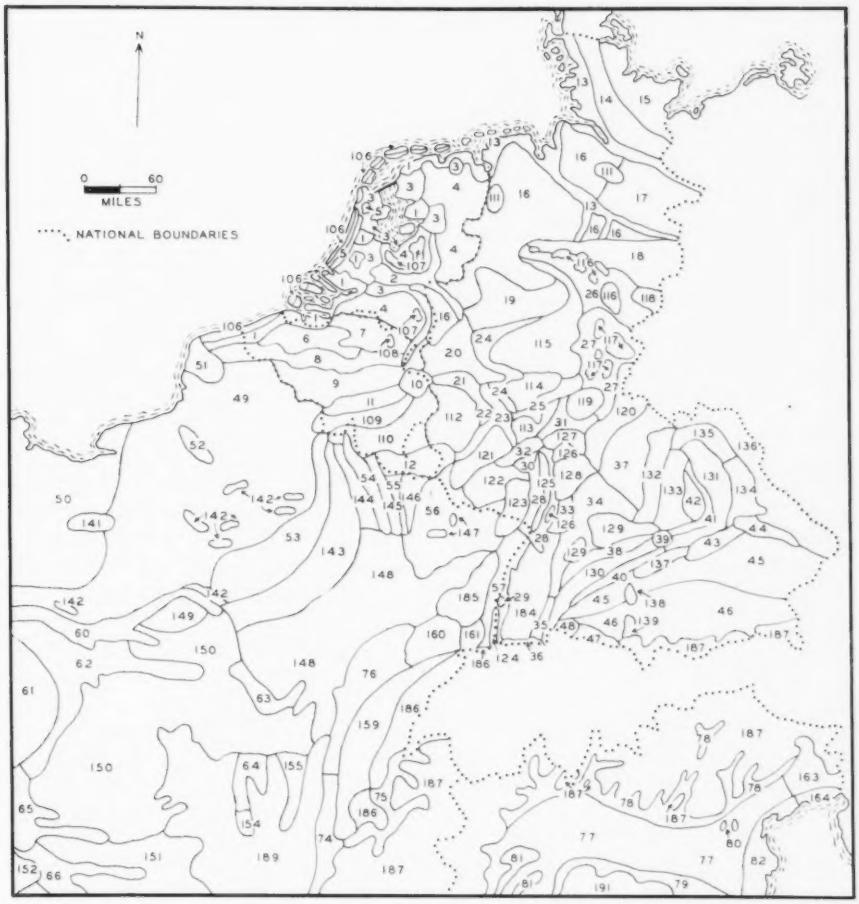

FIG. 4. Identification map showing productivity regions of Germany, Belgium-Luxembourg, the Netherlands, and neighboring areas in Common Market. For names of regions see Appendix.

smaller due to a smaller acreage of arable land. Interesting is the overall balance between cropland and grassland for the country as a whole, although it varies regionally. The agricultural regions are generally the continuation of those of adjacent Netherlands and France.

Regional Description

Behind a narrow wall of Dunes, the Polder area resembles the Sea Clay region (Region 1) of the Netherlands, of which it is the direct continuation, but it is much smaller in size (see Table VIII). As in the Netherlands cropland prevails (wheat and barley).

The high productivity of the Sandy Region of Flanders (Region 6) goes back to the Middle Ages when the sandy area hitherto used for sheep was converted into arable land. Crops cover a greater acreage than grass. The mixed type of farming combines

grain (rye, oats) with the raising of livestock and horticulture near the large cities. Holdings are small and fragmented, and present one of the problems Belgium faces if her agriculture is opened to competition.

The Campine (Region 7), the continuation of the sandy soils of the southern Netherlands, has been more recently put under cultivation; in fact there is still some waste land left. Yields are considerably lower than on the sandy region of Flanders; the 1956 yield of rye is 26.2 quintals per hectare in contrast to 30.8 in Flanders. Grass dominates over cropland and livestock is important.

The next two regions—the Sand-Loam area and the Loam region (Regions 8–9)—are the most productive part of Belgium. Large in size (42.8 per cent of the total arable land), the fertile loess soils, improved by fertilizers, produce the highest yields of the nation. Here most of the wheat and oats are grown; rye is relatively unimportant. Cropland covers about twice the area devoted to grass, but the combination of grass and forage crops favors the raising of livestock (cows and pigs). Here also is the center of the important beet sugar production as well as the horticulture, partly under glass. The small area of the second category in the south is the so-called Campine-hennuyere with sandy soils and low productivity.

South of the Sambre-Meuse, the agricultural picture changes. Grass replaces crops as the chief use of the land. The Condroz (Region 11), with its hilly topography, has considerable wheat and oats but the emphasis is on the livestock (dairy). A similar tendency is even more pronounced in the regions of the Grassland of Liège (Region 10), the northern foreland of the Ardennes, where grass covers more than 90 per cent of the arable land.

The two regions of the Ardennes, the Famenne and the Ardennes (Regions 109 and 110), with rough relief and cold, snowy winters have only limited value. A great deal is in forest. Cattle

TABLE VIII

STRUCTURE OF LAND USE IN BELGIUM, 1956

Agricultural regions	*Percentage of arable land*	*Percentage of total cropland*	*Percentage of total grass*	*Percentage of total horticulture*	*Per 100 ha. arable land*	
					Cattle	*Swine*
Polders-Dunes	4.8	5.6	4.1	1.7	157	95
Western Sandy Region	13.3	15.5	10.8	17.3	174	171
Campine	8.2	6.6	10.0	3.8	156	118
Sand-loam	20.0	25.0	14.9	26.0	137	100
Loam (loess) area	22.8	31.0	15.5	28.6	113	60
Grassland of Liège	5.2	0.5	9.0	19.6	243	160
Condroz	9.0	8.0	10.1	5.4	123	34
High Ardennes	2.1	0.2	3.8	....	176	33
Fagne	1.0	0.1	1.7	....	190	30
Famenne	4.1	0.5	6.0	....	130	26
Ardennes	7.5	0.9	9.0	....	142	38
Jurassic Region	2.1	1.1	2.9	....	112	73
Belgium	....	48.6	48.2	2.7	145	84

Areas in hectares

Arable land	1637
Total cropland	796
Total grass	786
Total horticulture	43

Data from Institut National de Statistique, Bruxelles, Belgium.

raising is the chief activity. Yields are low.

The last region, Region Jurassique, is part of a large zone, extending through southern Luxembourg (the so-called Gurland) into Germany. It is an area of mixed farming with more grassland than cropland. Although included in the higher category, it is near the limit.

Belgian Agrarian Economy and the Common Market

The Belgian agricultural economy is geared to home consumption and is protected against outside or foreign competition. Even the Benelux Union could not change that, as imports from the Netherlands were limited to contingents and minimum prices. Except for deficits in cereals, fats, and some dairy products (cheese) production is largely sufficient for internal consumption and there are even a few surpluses, such as sugar and horticultural products (hothouse grapes and the famous endives). Belgians eat well; the diet is especially high in the consumption of fruit, meat, eggs, and, especially, butter. The increase of production has been satisfactory; the only decline has been in potatoes. Imports, however, remain high; cereals, fruit, and wine are the major items. The problem which faces Belgium, if her productive system has to be modified gradually by a free flow of products within the Common Market, is the high costs of production. This is partly due to high cost of labor—much higher than in the Netherlands—but also to the small (almost minute) size of the properties, especially in the western part. In Belgium, 58.6 per cent of all properties are below five hectares in size, covering 22 per cent of the arable land. For the Netherlands, which also has many small properties especially in horticulture, the percentage is 39.9 per cent, covering 11 per cent of the arable land. The necessary land reforms will be a major operation.

The Netherlands

On the map of standard of land use practically all of the Netherlands is included in the category of relatively high productivity. The exceptions are the zone of dunes and some sections of the sandy soil regions, most of which are reserved for recreation.

The agricultural regions of the Netherlands are chiefly based on soil divisions and are, therefore, not always continuous. The only exception is the Horticultural Region (Region 5) which is also not a continuous one but based on the dominating type of land use (from a value point of view). For the Netherlands as a whole 39.1 per cent of the land under cultivation is in crops, 55.5 per cent is in grass, and 5.4 per cent is used for horticulture. The Sea Clay Region (Region 1), which accounts for 22.4 per cent of the cultivated land, is predominantly cropland—wheat, barley, sugar beets, and potatoes. The density of cows, which for the whole nation is 129 per 100 hectare of farm area, is only 67. The River Clay zone (Region 2) with 9.5 per cent of the total farm land has more grass (55.6 per cent) than crops (29.9 per cent), while the percentage in horticulture is rather high. Density of cows per hectare is double that of the Sea Clay Regions; there are also many pigs. The Grass Regions (Region 3) as the name indicates is predominantly in grass (87.5 per cent); density of cattle is very high (184 per 100 hectares). The Sand-Moor Region (Region 4) shows a difference between the sandy soils (42.8 per cent of the total cultivated land of the Netherlands) and the much smaller Moorland (3.9 per cent). On

the sand, grassland (59.9 per cent) prevails over cropland (37.3); rye and oats are the major grains. The density of cows is high (150 per 100 hectares). The Moorland is predominantly cropland (77.8 per cent) with emphasis on potatoes. The Sandy Region includes the core area of the very important chicken industry.

The Horticultural Region (Region 5) has 2.3 per cent of the Netherlands total with 39.3 per cent in horticultural crops, but areally grass prevails (52.4 per cent). Of the horticultural production, 122,800 hectares are on open ground and 4200 under glass. The open ground horticulture has 45,500 hectares in vegetables, 55,300 hectares in stone fruit, and 9300 hectares in flower bulbs. The hothouse production is chiefly vegetables (tomatoes) but also fruit (grapes) and flowers.

The standard of land use is one of the world's highest. Yields per acre are high and the average yield of milk per cow is above 4000 liters. The Netherlands uses the highest amount of fertilizer per hectare of any nation. Part of the feed, however, has to be imported, and, even then, in spite of high productivity, the government has to help the farmer financially in order to make export possible and the home consumption price within bounds.

Table II shows the relation between production expressed in percentage of the Common Market and the share of population. The Netherlands is generally low in grain (except rye) but high in livestock and horticulture. This is also well expressed in the table of self-sufficiency, with very high percentages for such products as fruit, meat, eggs, cheese, and butter, which are major exports. It is most interesting to discover that in all those products (except milk) the consumption is low, in order to allow for a large export. In order to have a large surplus available for export the Dutch eat relatively little meat, few eggs, and not much fruit. The index of production has increased rapidly since the prewar period except for bread grain and butter.

The result of this policy is that agricultural products provide 30.3 per cent of total exports by value in contrast to 3.5 per cent for Belgium, 10 per cent for France, 2 per cent for Germany, and 20 per cent for Italy. It is also the only country in Europe of which the value of agrarian exports is higher than that of agrarian imports. The total value of agricultural production in the Netherlands in 1955 was 4678 million guilders, comprising 1613 for crops (including horticulture) and 3065 for the livestock. This was

TABLE IX

STRUCTURE OF LAND USE IN THE NETHERLANDS, 1956

	Percentage of total arable land	*Percentage in*			*Cows per 100 hectare*	*Swine per 100 hectare*
		crop	*grass*	*horticulture*		
Sea Clay	22.4	68.1	26.6	5.3	67	18
River Clay	9.5	29.9	55.6	14.5	132	117
Grass region	19.1	8.9	87.5	3.6	184	95
Sandy region	42.8	37.5	59.9	2.6	150	153
Moorland	39.0	77.8	21.6	0.6	54	21
Horticulture	2.3	8.3	52.4	39.3	112	69
Netherlands	....	39.1	55.4	5.4	129	101

Data from *Statistiek van de land—en tuinbouw, 1956*, Central Bureau voor de Statistiek, Zeist, 1957.

10.5 per cent of the national product. Corresponding figures for Belgium are 6.67 per cent and for Italy 26 per cent. That 13 per cent of the active population, producing 10.5 per cent of the national product are responsible for 30 per cent of the export shows the importance of the Dutch agrarian economy.

The Netherlands within the Common Market

The agriculture of the Netherlands is a highly commercial enterprise with comparatively low costs, although the Government has to help financially by way of the Equalization Fund (in 1956 to an amount of about 50 million dollars). Production is quite intensive and, while improvements are constantly made (such as the combining of fragmented properties), the increase in production will be relatively small. At present about one-half of the agricultural exports go to the other nations of the Common Market, Germany alone taking one-half of these. If the Common Market decides to have a uniform tariff on some basic products such as grain and fats, this will have a direct influence on the Dutch price level because those products now enter freely. Another complication is the case of Denmark, which will be outside the Common Market and whose exports compete with those of the Netherlands. It is possible that if the Free Trade Zone, of which Denmark will be a member, does not develop, Denmark will ask to be included within the Common Market.

THE COMMON MARKET

The material presented in this article is far from complete and gives only a very general picture. But certain conclusions can be reached. The Common Market will never be self-supporting, especially as far as grain, tea, coffee, and fats are concerned. If French Tropical Africa is included, the fat situation will improve (peanut oil, palm oil) as will the import of bananas. Especially for grain, the supply will have to come from the outside. The need for that may somewhat decrease if France and Italy increase their grain production, which seems quite possible. Agricultural exports at present do not necessarily stay within the Common Market. Italy, for instance, sent only 10 per cent of her exports to the other members of the Common Market in 1955. Even less of her imports came from them. For the future one has also to consider changes in consumption, especially when the standard of living increases. Increases will be chiefly in such lines as meat, sugar, fruit, vegetables, and dairy products; decreases, in grain and potatoes.

The map of standard of land use shows a continuous productive area in the north and west as well as another large area in Northern Italy. Perhaps a third one (the Bavarian Plateau) should be added, an area of considerable size. Those areas, except for problems of economic adjustment, will probably be able to continue more or less as they are now if free trade within the Common Market becomes reality. The other areas of high productivity are more spotty and are often based on special crops such as fruit, vegetables, wine, and flowers. These will also survive without difficulty, although some of them are close to the border line of the top category.

More important is the evaluation of the less productive areas. The uplands of Germany, eastern Belgium, and eastern France will remain inferior; some may improve a little, others could better be left to forest. The same can be said of the mountain regions with definite limited possibilities. But the

chief problems are the large areas of the lower category which are not affected by factors of relief and climate. These are found in France south of the Loire and in sections of middle and southern Italy, including the large islands, Sicily and Sardinia. In those sections yields are low, cost price is high, and the population is poor. It has been pointed out both for France and Italy that there is reason to believe that some of them could be made more productive. These areas should be carefully studied with regard to their possibilities. Depopulation of the rural areas of southern France could be offset by immigration of farmers from the other members of the Common Market. The costs of improvement will become a Common Market problem and no more a national one. Here lies the major task for the Common Market.

APPENDIX

NAMES OF REGIONS

(Key to Figures 2, 3, and 4)

Regions of Relatively High Production

NETHERLANDS

1. Zeekleigebieden (sea clay)
2. Rivierkleigebieden (river clay)
3. Weidestreken (grassland)
4. Zandgronden en Hoogveen (sand and moor)
5. Tuinbouw (horticulture)

BELGIUM-LUXEMBOURG

6. Région sablonneuse (sand)
7. Campine
8. Transition (sand loam)
9. Région limonneuse
10. Région herbagère
11. Condroz
12. Gutland (Belgium-Luxembourg-Germany)

GERMANY

13. North Sea Marshland-Riverclay along Valleys of Elbe-Weser
14. Schleswig-Holstein (sand)
15. Schleswig-Holstein (loam area)
16. Low Geest (continuation of no. 4)
17. High Geest-Lüneburger Heide
18. Börde
19. Westfälische Börde-Münsterland
20. Kölner Bucht
21. Eifel Foreland
22. Mayen Plateau
23. Valleys of Mosel and Middle Rhine
24. Western Foreland of Westerwald and Schists Mountains
25. Valley of the Lahn
26. Weser Hills and Mountains
27. Basin of Upper Weser
28. Upper Rhine Plain
29. Kaiserstuhl
30. Hills of Rhine-Hessen
31. Wetterau
32. Rheingau-Plain of Nahe
33. Kraichgau
34. Neckar Basin
35. Baar-Klettgau
36. Southern Foreland of Black Forest
37. Basin of Middle Main-Tauber
38. Foreland Schwäbische Alb
39. Ries
40. South Slope Schwäbische Alb
41. Foreland Fränkische Alb
42. Plain of Regnitz
43. Donau-Moos
44. Dungau
45. Northern Bavarian Plateau
46. Southern Bavarian Plateau
47. Coastal Zone of Lake Constance
48. Hegau

FRANCE

49. Plain of Northern France, Eastern Part
50. Plain of Northern France, Western Part
51. Le Boulonnais
52. Le Braye
53. Champagne pouilleuse
54. Valley of the Meuse
55. Woëvre
56. Plateau of Lorraine
57. Alsace Rhine Valley
58. Northern Coastal Zone of Brittany
59. Southern Coastal Zone of Brittany
60. Valley of Lower Loire
61. Vendée-Lower Charente
62. Touraine-Anjou-Poitou
63. Valley of Central Loire
64. Limagne
65. Gironde-Lower Garonne and Lowe Dordogne
66. Central Garonne-Lower Lot

67. Upper Garonne-Lower Tarn
68. Lower Adour
69. Roussillon
70. Le Midi
71. Coastal Zone West of Rhône Delta
72. Coastal Zone East of Rhône Delta
73. Valley of Lower Rhône and Provence
74. Valley of Central Rhône
75. Valleys of the Savoye and Dauphiné
76. Saône Valley

ITALY

77. North Italian Plain
78. Pre-Alpine Hills and Upper Adige
79. Pre-Apennine Hills
80. Hills in North Italian Plain
81. Monferrata
82. Po Delta
83. Coastal Zone of Liguria and Northern Toscana
84. Basin of Lucca and Firenze
85. Basin of Perugia
86. Central Maremma
87. Monte Albani
88. Pontine Plain
89. Basin of Upper Pescara
90. Coastal Plain of Pescara
91. Basin of Fucino
92. Plain of Lower Volturno-Garigliano
93. Plain of Napoli
94. Coastal Zone of Salerno
95. Upper Sele Valley
96. Tavoliere
97. Coastal Zone of Bari-Brindisi
98. Coastal Section near Taranto
99. Plain of Gioia
100. Coastal Zone of Northern Sicily
101. Coastal Zone of Northwest Sicily
102. Coastal Zone of Northeast Sicily and Slopes of Etna
103. Region of Siracusa
104. Section along Southwest Coast of Sicily
105. Regions of Cagliari and Oristano

Regions of Relatively Low Production

NETHERLANDS

106. Dunes (also in Belgium and Germany)
107. Small Areas of Wasteland on Sand-Moor Region (simplified)

BELGIUM-LUXEMBOURG

108. Small Areas of Wasteland in the Campine (simplified)
109. Famenne
110. Ardennes

GERMANY

111. Areas of Wasteland in the Geest (simplified)
112. Eifel (continuation of No. 110)
113. Taunus
114. Westerland
115. Schists Mountains—Teutoburger Wald
116. Lower Weser Mountains (simplified)
117. Upper Weser Mountains (simplified)
118. Harz
119. Vogelsberg
120. Rhön-Spessart
121. Hunsrück
122. Nahe Mountains
123. Haardt
124. Rhine Floodplain, Southern Part
125. Rhine Floodplain, Northern Part
126. Forested sections in Rhine Plain
127. Lower Main Plain
128. Odenwald
129. Keuper Mountains
130. Schwäbische Alb
131. Fränkische Alb
132. Frankenhöhe-Steigerwald-Hassberge
133. Basin of Middle Franconia
134. Upper Pfalz
135. Upper Main
136. Mountains along Eastern Border
137. Donauried
138. Holzstöcke
139. Adelegg

FRANCE

140. Central Brittany (Bretagne)
141. Hills of La Perche
142. Forested Areas in Plain of Northern France (simplified)
143. Wet Champagne (Champagne humide)
144. Argonne Forest
145. Côte de Meuse
146. Côte de Moselle
147. Forested Sections of Plateau of Lorraine (simplified)
148. Escarpment Landscape of Southern Lorraine and Bourgogne
149. Sologne
150. Berry-Bourbonnais-Limousin-Périgord
151. Les Causses
152. Les Landes
153. Gascogne
154. Southern Limagne
155. Upper Loire
156. Camargue (Rhône Delta)
157. Crau
158. Depression between Massif des Maures and the Alps

159. Jura Foreland
160. Upper Saône Valley
161. Sundgau
162. Coastal Plains and Hills of Corsica

ITALY

163. Eastern Part of North Italian Plain (Friuli)
164. Eastern Coastal Zone
165. Central Toscana
166. Southern Toscana
167. Northern and Southern Maremma
168. Volcanic Plateau of Northern Lazio
169. Valley System of Tevere
170. Adriatic Coastal Zone and Hills
171. Campagna Romana
172. Upper Part of Valley System of Volturno-Garigliano
173. Monte Gargano
174. Murge
175. Peninsula Salentina
176. Altamura-Metaponte
177. Coastal Zone Western Calabria
178. Coastal Zone Eastern Calabria
179. Crati Valley
180. Central Plateau of La Sila
181. Central and Southern Sicily
182. Plain of Catania
183. Lowlands of Sardegna

Mountains

184. Schwarzwald
185. Vosges
186. Jura
187. Alps
188. Massif des Maures
189. Central Plateau and Cévennes
190. Pyrénées
191. Apennines (Appennino)
192. Mountains of Northern Sicily
193. Mountains of Sardegna
194. Mountains of Corsica

PROBLEMS OF MONOCULTURE AND DIVERSIFICATION IN A SUGAR ISLAND: MAURITIUS

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MAURITIUS became a one-crop sugar colony on the morrow of the Napoleonic wars. Under France the colonists had grown a variety of crops, but at this inauspicious time, when the slave trade was already outlawed in the British Empire, they embarked on a West Indian type plantation economy producing a crop which, in 1814, attained an all-time peak of £97 a ton c.i.f. London.[1] The price fell in the postwar depression, but remained above £30 a ton for many years.

The colonists succeeded remarkably. Acreage and production expanded rapidly. When slave labor failed, Mauritius pioneered the introduction of indentured Indian labor to the cane fields, and by the middle of the century had become the leading single cane sugar producer in the British Empire. Subsequently the island fell on bad times: malaria, plague, and hurricane added to the miseries induced by a secular fall in the sugar price, but no other activity arose to displace cane cultivation. Sugar cane continues to dominate Mauritius absolutely, probably more than any other territory is dominated by one activity. Sugar, molasses, and rum together account for over 98 per cent of exports, and the crop occupies 85 per cent of all arable land, 40 per cent of the whole island. There is no crop rotation.

[1] N. Deerr: *The History of Sugar* (London, 1950), II, 531.

Essentially, Mauritius is an industrial establishment exporting to live and, since the second quarter of the 19th century, importing almost all foodstuffs required, and other consumer goods. However, the establishment is imperfectly arranged for its function: there are too many people for efficiency, too many heritages from the past clutter the organization of the industry, and there are too many conflicts between the objectives of economic, social, and political policy. These latter are becoming crucial as the violent population upsurge of the last 15 years threatens the island with a grave "Malthusian" problem.

The Land

Mauritius is 720 square miles in area, comparable in size to an English county. The island is wholly volcanic in origin, resulting from three outbursts of vulcanism. The earliest of these built up a cone, which subsided, and the remains of the caldera wall survive in the jagged mountains which ring the central upland. This latter is composed of some 20 shield volcanoes sloping away to the coast from a crest line about 2000 feet high. The highest points in the island, on the southwestern plateau and on some of the caldera peaks, attain elevations of only between 2500 and 2700 feet.[2]

[2] E. S. W. Simpson: "The geology and mineral resources of Mauritius," *Colonial Geology and Mineral Resources*, 1, 3, (1950), 217–235.

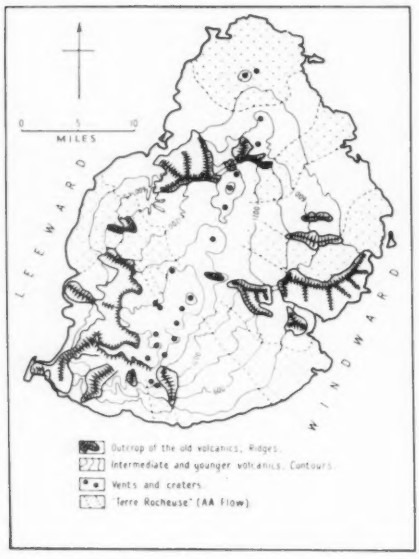

FIG. 1. The physique of Mauritius (geology after Simpson).

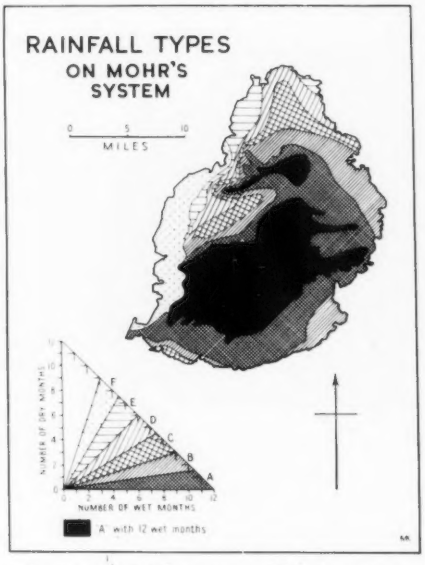

FIG. 2. Rainfall types on Mohr's system.

Notwithstanding this small relief there is considerable climatic variety. Rainfall and cloud conditions are dominated by the southeasterly airstream which is responsible for most of the precipitation except that derived from convectional showers or from tropical cyclones in the hottest months. The cyclones are a major climatic hazard: when they pass over or close to the island, they wreak great destruction. The cyclones of 1892 and 1945 each halved the sugar crop. However, liability to cyclones is a factor favoring monoculture of sugar, which has a greater wind resistance than most tropical crops.

Rainfall ranges from as little as 30 inches in sheltered locations on the leeward side to over 200 inches on parts of the central ridge and the southwestern plateau. On the windward slope there is an almost perfectly regular increase of 8 inches for each 100 feet of altitude.[3] Köppen's system puts most of Mauritius into the *Af* and *Aw* types, with an area of *Cf* in the center of the island. The semiaridity of the leeward side, and the considerable contrasts that do exist are best revealed by adopting the method suggested by Mohr and adapted by Schmidt and Ferguson in Indonesia.[4] This system, which is applicable only to the tropics, is based on rainfall data alone. The number of dry months (under 60 mm) is compared with the number of wet months (over 100 mm). The limits are empirically determined by soil moisture conditions in Java, where 100 mm gave a continually moist soil, but 60 mm allowed definite drying out. Figure 2 is a rough application of this method,

[3] M. V. M. Herchenroder: *La pluie á l'ile Maurice* (Port Louis, 1935).

[4] E. C. J. Mohr and F. A. Van Baren: *Tropical Soils* (2nd edit., The Hague, 1954), 30–72; F. H. Schmidt and J. H. A. Ferguson: "Rainfall types based on wet and dry period ratios for Indonesia with Western New Guinea," *Kementerian Perhubungan Djawatan Meteorologi dan Geofisik*, Verhand. 42 (Djakarta, 1952).

following Mohr in employing rainfall averages rather than Schmidt and Ferguson's more refined determination of the number of wet and dry months by averaging the values of each year. An additional class, showing those areas with no month under 100 mm is added.

It is remarkable that all types occurring in Indonesia (excepting only the arid Palu valley of Celebes) are found in Mauritius. Sometimes, too, the juxtaposition is quite exceptional. In the southwest the transition between A with 12 wet months, and the F type, having as many as seven dry months, occurs in the course of a few hundred yards down the steep scarp slope. This leeward coastal type is similar to the climate of the eastern Sunda islands or Port Moresby in Papua—all areas of little agricultural value.

A rough fourfold division of the island emerges: there is a dry western coastland, with a long dry season and rather uncertain wet season rainfall. This merges into a subhumid northern plain, characterized by a shorter but still well marked dry season. The southern and southeastern coastlands are humid with little dry season, and the center of the island is superhumid with no real breaks in a continuously moist climate. By virtue of its cloud cover as much as its altitude, the central upland is much cooler than the coast.

Soils in Mauritius show considerable variety, but are imperfectly understood. Six major types are recognized corresponding with the three main "climatic" classes—subhumid (30–50″), humid (50–100″) and superhumid (over 100″)—each cutting across two main classes of parent material on the newer basalts, the deeply weathered soils of the smooth flows, and the gravelly clay loams of the vesicular and *aa* flows (Fig. 1). In addition, a heavy clay developed at low altitudes in the west is recognized. Mild laterization is general, and leaching is more marked at high altitudes, where soil pH below 5 is commonly found. Soils on the older lavas have not been studied, but since slopes on these formations are mainly steep they have little agricultural significance. Recent studies have suggested similarities between the soils of Mauritius and those of Hawaii where an attempt has recently been made to systematize tropical soils. In Hawaii, however, the stony soils have passed out of sugar cultivation because of difficulties of mechanization and modern plantation operation. In Mauritius the stony soils form an integral part of the industry,[5] though often stones are so numerous that they are piled into walls and pyramids, and in parts cultivation is possible only by *muraille creole*—one row of canes, one of stones—a system that has some advantages for moisture conservation in dry areas.

THE SUGAR INDUSTRY

In the period of expansion that endured from 1815 until the 1860s, sugar cultivation spread from an early nucleus in the northern plain right around the island, leaving only the central area (roughly the 12 wet months zone) in forest. During this period the production of sugar increased almost pari passu with the input of land and labor: the supply of the latter was the main controlling factor in the rate of expansion. The introduction of malaria in 1865–1868 led to heavy loss of life in the coastal districts, and this disaster,

[5] P. Halais: "Données essentielles sur les sols de l'île Maurice," *La Revue Agricole de l'île Maurice*, 25 (1946), 192–197; M. Cline et al: *Soil Survey—Territory of Hawaii*, United States Department of Agriculture (1955); D. H. Parish and S. M. Feillafé: "Titration curves of some local soils," *Mauritius Sugar Industry Research Institute*, Annual Report, 1956, 43-46.

coupled with soil exhaustion and failing of mill water supplies due to forest clearance, led to the abandonment of numerous coastal estates, especially in the north. At the same time, however, some 9000 additional acres were cleared on the central uplands.

After 1880, the sugar price began a secular decline. Indebtedness mounted, and numerous estates began to be sold in small lots mainly to Indian cultivators who, only a few years before, had been indentured laborers. The number of factories tumbled from a peak of 258 about 1860 to only 104 in 1892 and 66 in 1908. The sale of estates, termed *morcellement*, proceeded most rapidly between 1880 and 1900. It was checked in 1902 by the effects of an outbreak of *surra*,[6] which wiped out a large part of the draught livestock and encouraged the rapid establishment of cane railway systems. The effect of these was to reduce costs of long haulage from field to mill, and to encourage consolidation of estates as an alternative to *morcellement*. There was a final burst of *morcellement* between 1910 and 1914, in a period of very low land values. By 1914 about half the cane land was in the hands of small proprietors, but since that time the trend has been toward re-aggregation into larger units.[7]

Until approximately 1895 the yield of sugar remained very constant at about one ton per arpent.[8] There was then a substantial improvement up to about 1908, due to improvement in cultivation practices, the use of manure and artificial fertilizers, and the widespread replacement of the ancient *Creole* and *Otahetie* varieties by the higher yielding *Tanna* from the New Hebrides. There was then a boom from 1915 to 1925, the price of sugar rising to a maximum of £58 a ton c.i.f. London in 1920. In Mauritius, as in other cane growing areas, this boom led to a rapid increase in the area of sugar, to large scale land sales at inflated prices, but to very little real progress in the industry. The "false dawn" did great damage. It is traditional in Mauritius for a high proportion not only of fixed capital but also of working capital to be obtained under mortgage from a *bailleur de fonds*, who is generally also a sugar broker. A heavy burden of fixed repayments was taken on during the boom, and this became insupportable during the subsequent depression. The period from 1925 to 1940 was the worst in the whole history of sugar. From 1929 to 1940 the c.i.f. London price never rose above £10 a ton, and in 1934 it fell below £4. Though costs were pared to the minimum, bringing wages to starvation level and below, the burden of debt was irremovable. The *bailleurs de fonds* themselves were often unable to realize any profit on their capital, and though they became virtual owners and operators of many estates and smaller holdings, they were often creditors for more than the total value of the land and improvements. An Agricultural Bank and Co-operative Credit Societies were formed, mainly to help the small growers, but not these aids, nor the *de facto* subsidy of Imperial Preference could really lift the industry out of its slough until the depression ended.[9]

[6] An animal trypanosomiasis, borne by *T. evansi*.

[7] A. North Coombes: *The evolution of sugar cane culture in Mauritius* (Port Louis, 1937); the story of settlement and the spread of population in Mauritius, with an analysis of the changes in the sugar industry in so far as they bear on this, is more fully treated, with full references, in H. C. Brookfield: "Population distribution in Mauritius," *Malayan Journal of Tropical Geography* (in press).

[8] One arpent = 1.043 acres.

[9] Colonial Office, Cmd. 4034, *Report of Commission on the financial situation of Mauritius* (1931); P. de Sornay: *La canne à sucre a l'ile Maurice* (Paris, 1920); Sir Alan Pim: *Colonial*

(*Continued on next page*)

Some relief was, however, obtained in the thirties by a renewed improvement in yield. In large measure this was due to the work of the sugar experimental station, which introduced several new varieties. *Tanna*, which had been the principal Mauritian cane since the 1890s, diminished from 57 per cent to only 5 per cent of the cane land area between 1930 and 1944, its place being taken by a variety of new canes, of which the most successful was a Caribbean variety, BH 10/12, which covered 40 per cent of the cane lands by 1940. Then in 1937 came the first major Mauritian variety, M 134/32, by far the highest yielding cane thus far employed in the island. The spread of this cane was slow because of the unusually long ratooning cycle practiced in Mauritius—it is by no means uncommon for as many as six ratoons to be taken before cane is replanted—but by 1950 this cane covered 91 per cent of the cane area. A large part of the massive increase in production that has taken place since 1938 is attributable to the use of this variety alone.

Prices rose steadily after 1939, though compulsory wartime food planting and devastating cyclones in 1944 and 1945 held the industry back. After 1946, however, rising prices, the spread of M 134/32, and a guaranteed market first in British contracts then within the Commonwealth Sugar Agreement,[10] combined to restore the industry to a favorable financial position. There has been substantial investment, bringing the industry to a much higher level of efficiency. However, since about 1953 the guaranteed market within the Agreement, which absorbs normally over 80 per cent of Mauritian exports at the guaranteed price, has ceased its rapid expansion. Prices have become stable, and the world "free" price recessed. Though failure of other producers to utilize fully their quotas has spared Mauritius the need to restrict output, an increasingly static market, more stable prices, and still rising costs[11] would seem to herald a renewed period of some difficulty for the industry.

THE DISTRIBUTION AND STRUCTURE OF THE SUGAR INDUSTRY

In order to comprehend the problem facing the industry and the island, it is necessary to examine the sugar industry structure (Fig. 3). Virtually all land that is suitable for cane, other than that under towns and villages, is under the crop. High prices and M 134/32 have brought much formerly sub-marginal land back into cultivation in the north and west, while on the uplands better fertilization, and control of diseases has extended the boundary of cultivation into the superhumid margin.

Agricultural Production (London, 1946), pp. 71–76. Geographical accounts of the industry in the early thirties are to be found in G. J. Robertson: "The Sugar Industry of Mauritius," *Econ. Geogr.*, Vol. 6, 1930, pp. 338–351; and P. Caubert: "La canne à sucre a l'île Maurice," *Annales de Géographie*, Vol. 42, 1933, pp. 516–528. A more recent survey is to be found in C. Robequain: "Destin d'une île à sucre: l'economie et le peuplement de Maurice," *Annales de Géographie*, Vol. 63, 1954, pp. 255–273.

[10] The market for Mauritian sugar has changed substantially during its history. Initially this market was in Europe, then in India, South Africa and Australia. Growth of production in these three areas in the present century has forced a return to the British market, with the addition of Canada. The United Kingdom and Canada now take the bulk of the crop. Only some 25,000 tons a year are consumed locally.

[11] Among these costs is the sea freight rate, which the Mauritian producer has to absorb. In 1956, when rates rose to a high peak due to the Suez crisis, growers realized only £33/7/6 net per ton of a c.i.f. London price of £40/15/0. Low freight rates in 1957 permitted a better return. It is noteworthy, however, that in 1956 Mauritian producers still fared better than South African producers, who sell the bulk of their sugar in a controlled-price local market; they realized only £26/12/2 a ton. Absence of a local market is not wholly disadvantageous except in times of low world prices. Barclays Bank (DCO), *Overseas Survey* (London, 1957); *South African Sugar Journal*, 41, 7 (July, 1957), 537.

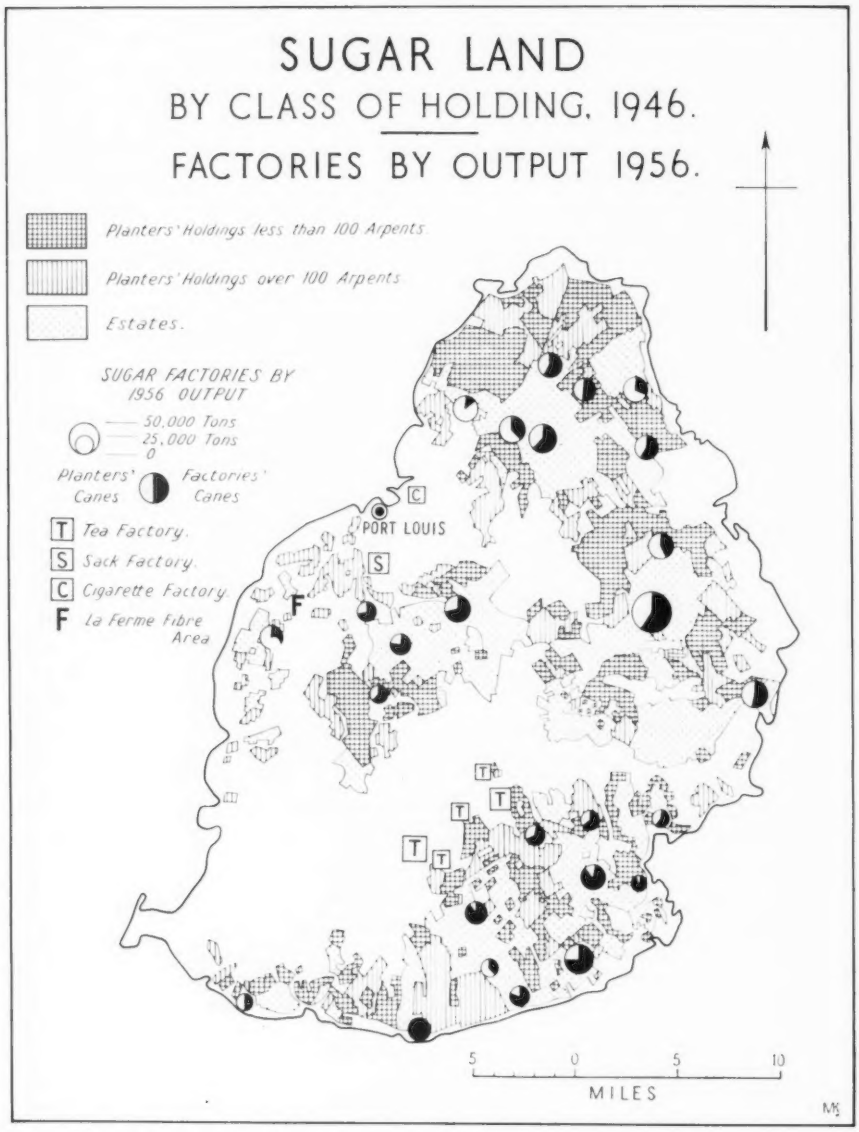

FIG. 3. Sugar land by class of holding, 1946, and factories by output, 1956. (Data from *Mauritius Economic Commission*, Part 2, 1949; and Mauritius Sugar Industry Research Institute, *Annual Report*, 1956.)

TABLE I

CANE PRODUCTION PER ARPENT AND COST PER TON BY CLIMATIC TYPE AND CLASS OF HOLDING

	Subhumid less than 50 inches		*Humid 50–100 inches*		*Superhumid more than 100 inches*	
	Tons/arp	*Rs/ton*	*Tons/arp*	*Rs/ton*	*Tons/arp*	*Rs/ton*
Estates	26.5	13.7	26.5	13.2	24.6	13.7
Large planters	18.5	....	22.7	....	19.6	....
Small planters	16.8	11.3	18.0	10.3	15.4	11.8
Very small planters	15.1	8.6	15.7	8.5	12.9	9.9

From *Mauritius Economic Commission Report* (1949), Part 2, unpublished.

Cane cultivation extends through the A to E climatic zones, except where conditions are too bouldery, or where wind exposure on dry coasts generates local drought. Some 16,000 acres are irrigated, mostly in the F zone, though furrow irrigation is used in the D and E zones to minimize the effects of the dry season. Optimum yields occur in the borderlands of the A and B zones, but the B zone probably provides minimum cost conditions, for less fertilizer and many fewer weedings are required.[12] Fertilizer and weeding costs increase rapidly with the onset of superhumid conditions, though new cane varieties, notably *Ebène* 1/37, have been developed in recent years to overcome these disadvantages by offering optimal yields under much wetter conditions than M 134/32. A feature of the past seven years has been the beginning of regional specialization in cane types. Previously one variety, be it *Otahetie*, *Tanna*, or M 134/32, dominated the whole island; now there is still M 134/32 in the drier north, new Barbados varieties and *Ebène* 1/37 on the uplands, and new Mauritian varieties in the intermediate areas.[13] Replacement, however, is slow because of long ratooning: 80–85 per cent of the weight of cane cut each year is ratoon cane.

Variation in cost and yield with climate is, however, much less than variation with type of grower. In 1946, there were 30 "factory estates," 109 other "estates" and "planters" who each cultivated over 100 arpents (104.3 acres), 13,685 "small planters" cultivating areas ranging from 99 arpents down to a single row of canes, and finally some 2900 *metayers*, frequently part-time estate laborers, who cultivated some of the land of 12 estates and 20 large planters on a share-cropping basis.[14] A survey made in 1946 produced the results shown in Table I.

While it is true that the small growers, and especially the very small growers, generally farm the inferior land and frequently cultivate marginal land, it is also clear from this table that they produce not only less efficiently but also less intensively than the larger growers. Despite the increase in both costs and yields since 1946, the relationships shown in this table have not been substantially disturbed in the interim. The smaller grower, lacking fixed or

[12] Colony of Mauritius, *Mauritius Economic Commission Report* (1949), Part 1 (published) and Part 2 (unpublished) contain a mass of data on the costs of the sugar industry, with much material on regional and climatic differentials that is quite unobtainable elsewhere. This source is relied on heavily in the present section.

[13] *Mauritius Sugar Industry Research Institute*, Annual Reports.

[14] In Mauritian usage a "planter" is a small-grower. An "estate" is a holding to which a permanent name attaches, though its use is sometimes confined to the large holdings with factories. In this paper Mauritian usage is followed, except that the term "plantation system" has its general meaning.

working capital, fertilizes less, weeds less, uses less machinery, and most probably ratoons his canes for longer than the estates. The small grower's low cost operation was well suited to the low returns of the period between the wars; high prices, however, have rewarded the increased capitalization that only the estates and a few large planters can afford.[15]

There are some additional considerations affecting the estates with factories which are operating to widen the differential between the different classes of grower. They arise from the fact, which has held good for many years, that factory operation is more profitable than cultivation. The *Mauritius Economic Commission* derived the following interesting information:

DISTRIBUTION OF THE NET PROFIT OF THE ESTATE COMPANIES

	1938 *Rs000*	*1946* *Rs000*
From estates' cane cultivation.....	1,614	2,014
From manufacture: estates' cane...	2,374	5,243
planters' cane..	2,257	3,024

Of the increase in profits on estates' canes between 1938 and 1946 over 80 per cent was derived from manufacture. The milling process demands large capital costs but low running costs: marginal return from increases in the quantity of cane handled is therefore at a maximum when the mill is large and running at full capacity. For the industry as a whole it is clearly most profitable to maximize production per factory; this is the main reason for consolidation of factories. For the estates with factory this also means that it is most profitable to capitalize cultivation so as to expand the throughput of the factory. No such considerations affect the Mauritian small grower, for the factories are wholly controlled by the estates. Small growers' co-operatives are limited to the provision of working capital for cultivation, and there is no co-operative milling such as has developed on an extensive scale in Australia.

Thus while estate profits are dominated by factory considerations, and intensive capitalization in cultivation may earn its reward in factory rather than in field operation, the small grower's scale of production is in theory determined by profits to be made on cultivation alone, and in practice also by limitations of working capital. In a period of good prices and heavy investment in the industry,[16] these considerations operate to sharpen the differential between the estates and the smaller growers. The plantation economy is thus revitalized, and the trend toward peasant production, which has not been pronounced in Mauritius since 1915, has now been firmly reversed.

THE FUTURE OF THE SUGAR INDUSTRY

We approach the crux of the problem posed in the introduction to this paper: there are conflicts between the objectives of economic, social, and political policy, conflicts that are sharpened by the rapid upsurge in population. One plane of conflict has already become apparent: the renascence of the plantation economy is leading to a progressive reduction in the proportion of small growers' land, and the circum-

[15] With a price of Rs 20 per ton, and costs and yields as in Table I, an estate farming subhumid land would obtain a net return of Rs 76 per arpent, a very small planter Rs 168. With a price of Rs 40 per ton, an estate would receive Rs 606 per arpent, a very small planter only Rs 470.

[16] In 1946 the fixed capital of the estates was valued at Rs 133,000,000 of which Rs 59,000,000 represented land and Rs 74,000,000 was the valuation of factory equipment, rolling stock, and buildings. Since then over Rs 200,000,000 has been invested, virtually entirely from the industry's own profits, in the factories alone.

FIG. 4. A sugar estate in southern Mauritius. (Aircraft Operating Company of Africa, Ref. No. F. 16193.)

stances of the industry are sharpening the differential between the big and the small man. In a colony now advancing rapidly toward self-government with universal franchise, this economic development clearly runs counter to the social policies of a Labor Party government, even though most of the estate proprietors are themselves Mauritians.

Much sharper conflicts may, however, emerge from the growing pressure on the industry for major rationalization in an effort to remain competitive with other sugar areas. The industry is now operating on a smaller profit margin than in the halcyon days around 1950. The problem posed by rising costs and steady prices has been kept at bay by continued increases in yield, but this solution brings in its train the danger of overproduction. Steps to obtain economy, to maximize output per factory, to reduce transportation costs, and to increase efficiency are now the order of the day. Though the Mauritian industry produces a very high quality sugar with an average

polarization above 98°,[17] it is tending to fall behind in some of these respects.

Mechanization, longer ratooning, and canes which will mature earlier in the season are the main lines of advance in the field side, and in these directions good progress is being made. Mechanical destoning, carried out by the estates or by the Government on some small-planters' land, facilitates mechanized operation, and the new canes show not only much higher ratooning qualities but also in some cases greater disease resistance, which will increase returns. It is, however, in the factory and transport sides of the industry that the most dramatic improvements may well lie. Mauritius had 30 factories in operation in 1946, and in 1949 the *Economic Commission* recommended a reduction to 18 in five years. There are still 26, producing quantities of sugar ranging from 55,000 tons to below 10,000 tons (Fig. 3). Though the small mills produce with lower overhead charges, their costs per ton are much higher than for the larger mills.

By modern standards this is small scale operation. The larger Natal industry has only 17 mills, of which 9 produce more than 50,000 tons (against one in Mauritius), and three are in the 100,000 ton class in good years. The Mauritian cane areas are mostly in open terrain and are compact; there are not the numerous fragments of cane land which aid the survival of very small mills in parts of Queensland, for example. Though the capital cost of consolidation is very large, there seems little doubt that the Mauritian industry could produce more economically with a quarter of the present number of factories.

Allied to centralization, but more immediately likely of realization, is the prospect of a major change in the whole system of cane and raw sugar transportation. At present cane is carried to the mill by a too-light cane railway system, by bullock cart, over short distances of the Mauritius Government Railway, or rarely, and experimentally, by truck. Raw sugar is bagged at the mill, and taken by Government Railway to Port Louis. At Port Louis it is stored, and lightered out to ships in the roadstead, being exported in bags.

Change is possible in every part of this structure. Other areas, notably Hawaii, have demonstrated conclusively that road transport is more economic than rail at all stages; the last cane railway system has now disappeared from Hawaii. Road transport of canes, with vehicular collection from the fields has been tried with great success in South Africa, and experiments in Mauritius have proved successful. Road transport to Port Louis would certainly be cheaper than the railway system, which is at present subsidized by Government-backed deficit operation. Experiments in bulk shipment have proved successful, though there is yet no bulk handling plant, and bags are simply tipped into ships' holds. The installation of full bulk handling at all stages from factory to ship, with bulk storage and loading plant at Port Louis, must be regarded as a probable development. This change, above all others, would immediately displace a

[17] The Mauritian industry was formerly almost unique among colonial exporters in producing 99° polarization "plantation white" sugar. When Britain imposed penalties on sugars with over 99° polarization (i.e., purity) in order to protect the British refining industry and to ensure that unrefined sugar was not placed on the British market, Mauritius was forced to lower the quality of its raw sugar. However, quality still remains above the average. This question, together with the general question of the location of the sugar refining industry (as distinct from the sugar milling industry), is discussed with considerable reference to Mauritius in Charlotte Leubuscher: *The processing of colonial raw materials, A study in location* (London, Colonial Office, 1951).

large force of workers on the railways, the docks, and in the whole Mauritius fiber industry, which would be completely destroyed. Yet the change, and other changes here reviewed, are probably essential for the future of the sugar industry.

The problem is aggravated by the fact that in almost every way the new phase of the industry is capital rather than labor intensive. In the past labor shortage has been almost traditional in Mauritius and only in periods of depression has there hitherto been a surplus. Improvements in yield have been achieved without increases in the labor force; the sugar industry employs no more today than in 1920, when production was less than half present levels. This trend has had beneficial effects so long as the working population remained static: after the cessation of large Indian immigration the male population actually declined for many years, and only began to rise again after 1930. In fact the male population between 15 and 64 was only a few score larger in 1952 than in 1881. This state of affairs, brought about first by an unbalanced age-sex structure, then by persistent high mortality, is now at an end. In recent years, the elimination of malaria and general improvements in welfare have led to an explosive population increase. Natural increase has added some 200,000 to a 1944 population little over 400,000.

So far, the impact of this upsurge has been felt chiefly in an increased burden of dependency; only now is it beginning to affect the size of the work force. Yet within 20 years it is more than probable that the numbers in the 15–64 age group will have doubled.[18]

[18] The material in this section is more fully treated in H. C. Brookfield: "Mauritius; demographic upsurge and prospect," *Population Studies*, Vol. 11, 1957, pp. 102–122.

It is against this background that we must view developments in the sugar industry, which will tend to diminish the demand for labor in the industry that employs all but a few thousands of those engaged in primary and secondary production, and to destroy important ancillary activities.

It is traditionally argued that increasing returns from sugar will offset these disadvantages by generating new demand and by making possible the capitalization of new forms of activity. This solution may, however, not be valid for Mauritius. There is a shortage of investment opportunity except in the sugar industry itself, and there has indeed been a net outflow of capital from Mauritius in recent years, while the rate of fixed capital formation, at some 12–14 per cent of the gross domestic product, is not high for an industrial economy.[19] Should an inflow of capital be attracted to the colony, it would most probably be for purposes connected with sugar. It is ominous that even with the rising returns of recent years, per capita real income at 1948 prices has remained around Rs 700–750 (£stg 50–56) throughout the 1948–54 period.[20] Prospects of rising demand per capita are not bright.

These are perhaps surprising observations in view of the fact that large parts of Mauritius are unused, and that there are other economic activities in existence. However, the relationship of these other activities to sugar is marginal in either a geographical or economic sense, or both.[21] A study of

[19] Colony of Mauritius, Central Statistical Office, *The national income and national accounts of Mauritius, 1948–1954* (Port Louis, 1956).

[20] *Ibid.*

[21] The concept of the margin is here used in the sense of the geographical and economic margin between activities. Other things being equal, the activity yielding the highest *rent* will be followed. Where the *rent* from sugar falls below that from tea or fiber cultivation the

(*Continued on next page*)

their development, distribution, and problems will cast much light on the problems of monoculture and diversification that have been laid bare.

THE TEA INDUSTRY

The most important of the subsidiary crops is tea, and it is on tea cultivation that the main hopes of agricultural diversification are all pinned at the present time. Tea was introduced to Mauritius in the 18th century by the Intendant Poivre, who introduced a wide variety of crops, trees, and bushes into the island, established the famous Botanical Gardens at Pamplemousses, and made the island a center from which seeds and seedlings were disseminated over a wide area.[22] There was some early 19th century production of tea in the east, but it gave way to sugar. Later in the century an experimental plantation was established on the uplands, beyond the superhumid limit for sugar. The crop became well established in various parts of the A (with 12 wet months) zone during the 1890s, when a factory was built and some 500 arpents were planted. The rise in labor costs during the 1914–18 war led to some decline in tea and some tea land was transferred to cane to take advantage of high sugar prices. This was subsequently abandoned, and in the thirties low wages again encouraged a revival of tea. Quality remained poor, however, for virtually no new bushes had been introduced since 1900 and the industry supplied no more than a part of the local demand.

After 1945 the Government took a hand in the tea industry with a view to developing tea as a second major crop; the rapid growth of population gave increasing urgency to this policy as time went on. Government has assisted in the modernization of factories, has established an experimental station and an extension service, has imported new high quality strains from Nyasaland and India, and has assisted planters with the clearing of new intakes of Crown Land. The crop has now been raised to about 1,500,000 pounds of tea of which a substantial proportion, derived so far from only one factory, is exportable. Production exceeds local demand. However, all this effort has only led to an extension of the tea area from 1000 to 2500 arpents, and it is variously estimated that between 15,000 and 30,000 arpents are suited to the crop.[23]

Several circumstances combine to bring about this lag. Old, low-yielding badly planted bushes and unenterprising cultivation and factory operation are partly responsible; though average yield has been improved from around 400 to nearly 700 pounds per arpent, some high-quality bushes have yielded over 1000 pounds experimentally. There have been labor difficulties, for tea cultivation requires about one laborer

margin of sugar cultivation will occur. The theoretical considerations underlying this approach to land use differentiation are treated in J. Robinson: *The Economics of Imperfect Competition* (London, 1933), pp. 102–119; ("A digression on rent") in A. Lösch (trs. W. H. Wolgrom), *The Economics of Location* (New Haven, 1954), esp. pp. 36–67; and in E. M. Hoover, *The Location of Economic Activity* (New York, 1948), pp. 90–102. The term *rent* is in this paper used in the classical economist's sense of the surplus earned by a factor of production over and above the minimum necessary to induce it to do its work. Land which earns no *rent* is thus at or below the margin of economic use; land which earns equal rent under sugar or under tea is at the margin of use for sugar or for tea. All land in profitable use earns *rent*, the better land earning more than the poorer. The concept is closely allied with that of the "free gifts of nature."

[22] Cloves were almost certainly introduced to Zanzibar from Mauritius. They came to Mauritius from the Moluccas under Poivre.

[23] Tea possibilities have been subject to intermittent examination for many years. A full survey of the history of the crop is contained in the centenary publication (1954) of the *Chambre d'agriculture de l'ile Maurice.*

FIG. 5 (left). The Port Louis mountains across the northern plain.

FIG. 6 (right). Bouldery land recently cleared and planted to tea on the central uplands.

per acre during a flush season that overlaps the sugar crop season, and tea plantations are mostly in unsettled areas, without readily available local labor. Labor has furthermore been more costly since the war, and there is no body of working people skilled in tea. The slow growth of the crop in Mauritius—some 18 months above 1500 feet—is unattractive to growers with little capital. The main fault, however, is simply lack of capitalization itself. Tea cultivation in Mauritius is a small planters' business and few new entrants to the business have had adequate resources. In 1956 the Legislative Council determined on strong action to end this situation: a program was launched at a cost of Rs 4,000,000 to bring a further 3000 arpents under cultivation by 1960. Some land is being wholly cleared, destoned, prepared, and planted before being leased to smallholders, while elsewhere assistance is being provided with clearing, seeding, and fertilizing, and providing roads and labor housing to serve some 2500 arpents. Nearly all this new tea land is taken in from the waste; very little is abstracted from sugar. Indeed on the tea/sugar margin, the combination of a new rise in the price of sugar with the introduction of canes which yield better under superhumid conditions might yet throw substantial tea areas in jeopardy.

The future of tea in Mauritius is not yet assured. Labor needs are large and wages higher than in most tea producing areas. Though the industry must now export, the local market still takes the bulk of the crop and is the more remunerative. Prospects depend on increasing yield and in securing economies of scale. However, Government help now seems assured for the value of a second crop—one with a notably stable market, and which will absorb much labor—is now well appreciated in Mauritius.

THE FIBER INDUSTRY

The problems which beset the development of tea face the other subsidiary activities in a more formidable form. The position of the fiber industry is now desperate. The subhumid western side of the island has extensive areas of aloe (*furcraea gigantea*) which has become wild and spread widely from some initial 18th century plantings. Some attempts have also been made to plant sisal, and this too has run wild, though less extensively. With some Government support, a part-extractive part-cultivated production of fiber has been developed for the manufacture of sugar bags. The main area

of production is in a small tract receiving from 35 to 45 inches of rain near the La Ferme reservoir (Fig. 3), where both *furcraea* and sisal are planted. Nearly half the total production comes from here. Elsewhere the industry depends mainly on wild *furcraea*, but the sources are small and scattered and are limited in value by drought, by heavy clay soils, and by the fact that the most productive areas are also marginal for other activities yielding more *rent*—tobacco, coastal casuarina plantations, and sugar itself. In 1948 it was estimated that there were some 7500 arpents of productive *furcraea* and sisal, sufficient to supply about a fifth of the sugar industry demand. Since then M 134/32 has made further inroads into the fiber area, and has raised much of the best fiber land above the economic margin for sugar cultivation.[24]

The fiber industry is primitive in organization. There are 30 decorticating plants, of which half a dozen produce most of the output. A few years ago over 40 were in operation. Fibers go to a sack factory which was erected by the Government in the middle of the depression in 1932. Unfortunately, this stimulus did not succeed in drawing capital into the industry, and Mauritius has never been able to produce sugar bags at a cost below the c.i.f. price of imported Indian jute bags. The prolonged world shortage of jute bags after the war gave some encouragement to the industry, but recently this has ended, and at the same time experiments in bulk loading of sugar have undermined the whole basis of the industry. The sugar industry continues to buy local bags under an agreement which terminates in 1958: already the sack factory has been forced to reduce payments to growers in two successive years, and with returns now marginal for most of the industry, deficit financing of the Government sack factory has been resorted to in 1957. With a major change to bulk loading of sugar in prospect, there would seem little point in persisting with this enterprise.

[24] Colony of Mauritius, *Report on the Mauritius Fibre Industry* by G. W. Lock and P. W. Lees (Port Louis, 1948); *Chambre d'agriculture de l'ile Maurice, Centenary publication* (1954); Department of Agriculture, *Annual reports*.

OTHER FORMS OF ECONOMIC ACTIVITY

There remain the activities geared to local consumption: food crops, meat and dairy produce, and tobacco. Of these only tobacco supplies any substantial proportion of the local market: more than half the weight of leaf and one-third of the value of tobacco smoked in the island are locally produced, mainly in the subhumid coastlands of the north and northeast. Nearly 700 arpents are planted, the area being limited by the Tobacco Board according to the requirements of the cigarette company in Port Louis. An effort is being made to replace Amarello by Virginian and to improve the color of leaf. This will ensure a larger share of the higher priced grades in the local market; there is, however, no hope of export, for Mauritian costs are higher than Rhodesian and even were costs equal the small scale of production in Mauritius would make export uneconomic.[25]

The area under food crops has diminished rapidly since war-time and post-war subsidies were withdrawn in 1950. Most food crop land has reverted to sugar cane, and what remains consists mainly of maize in the remote southwest and high *rent* activities such as market gardening near the towns or the irrigated onion culture of an isolated valley on the east coast. The food supply of Mauritius is derived almost

[25] Colony of Mauritius, Department of Agriculture *Reports*.

wholly from overseas. Rice, which is the principal item of diet, is imported under agreement from Burma. Meat comes mainly from Madagascar, wheat from Australia, and fruit from South Africa. The relationship of food production to sugar production in Mauritius provides a neat illustration of the principle of comparative cost. Only vegetables, fish, and milk are entirely locally produced, the latter mainly from stall-fed animals kept by several thousand individual cow-keepers. There is very little grass farming.

There remain some 50,000 arpents of "permanent waste" in Mauritius. While some of this is too wet and cloudy, too dry, too bouldery or too steep for cultivation of any kind, much of it is, in fact, usable in one way or another. Possibly some 20,000 or more arpents will be sown to tea, but there remain large areas which could, with suitable preparation, be afforested, become reasonable pastures, or grow potatoes—a crop which is in large demand.[26] However, the problems of marginality, capital shortage, and the sheer limitations of a small and poor market would beset all such experiments. The best land is pre-empted for cane; what remains is rarely best suited to the crops that are tried upon it. The local market is very restricted, and the isolation and small size of Mauritius, together with the fact that generally lower wage scales operate in neighboring territories, make it well nigh impossible to establish a regional market and very difficult to enter new export fields. Notwithstanding the availability of land, labor, a good road system, electric power, and other services therefore, the creation and development of new activities presents formidable problems.

A word should be said about the consequences of sugar monoculture on activities other than primary production. Absolute dependence on export has brought about an unusual degree of concentration into the port, on which all communications converge, linking all parts of the island readily with the capital. All those activities which require overseas raw materials and local distribution are clustered in Port Louis, mostly near the port. The small match industry, the manufacture of soft drinks, cigarettes (employing both local and imported leaf), wine bottling, wine and rum compounding (using local rum), leather work and ice cream making are all entirely in Port Louis, which also has all but two of the wholesale establishments and 60 of the 70 banking and commercial establishments in the colony. Mobility of goods is not paralleled by comparable mobility of population, and the retail trade and such service industries as clothing and furniture making are far less centralized. Industries processing the primary products are not centralized at all, with the sole partial exception of the cigarette factory:[27] for the primary industries Port Louis is the funnel through which

[26] Potatoes have shown good results experimentally, but there are serious problems of disease, of soil acidity on the high ground, and of deterioration and liability to pests in storage other than cold storage. (Department of Agriculture, *Report*, 1955); The possible future of much of the sub-marginal land is discussed, perhaps over-optimistically, in Colony of Mauritius, *Report on the possibilities of land settlement in Mauritius*, by J. Bett (1948).

[27] In each of the processing industries—sugar milling, fiber decorticating, and tea drying and preparation—the operation of Weber's loss-of-weight factor may be clearly demonstrated. Sugar milling has a loss-of-weight factor of about 8 (vide W. Smith, "The location of industry," *Transactions and Papers, Institute of British Geographers*, 21 (1955), pp. 1–18; A. Weber, *Theory of the location of industries*, Translated, with introduction and notes, by C. J. Friedrich (1929). The operation of this factor is, however, diminished by the advantages of large scale operation; and current measures to reduce transport costs, by giving greater weight to processing costs, will reinforce this tendency.

passes their trade. The other activities of the capital stem from this function.

CONCLUSION

Monoculture of sugar has brought advantages to Mauritius: it has made possible the maintenance of a substantially larger population at a better standard of living than would have been possible under any form of subsistence cultivation. It has created within the island an efficient industry, enjoying many economies of scale, and served by a labor force well versed and skilled in the production of sugar. There is, however, a reverse to the medal. Monoculture has brought Mauritius into a position in which the demands of the dominant industry inhibit the development of others. These demands are leading to moves which are re-establishing the plantation in a more massive and capitalized form—a development that could have far reaching effects on capital/peasant and capital/labor relations of great moment in a territory on the verge of quasi-autonomy with universal suffrage. The drive for efficiency actually threatens to aggravate an already desperate population problem. Yet can the sugar industry prosper without a drive for efficiency? And can Mauritius survive without a viable sugar industry?

The remedy would seem to lie at least in large part in diversification. However, all possible activities are either tied, as is sugar, to the export market, or else are throttled by the small size and poverty of the local market. An examination of the subsidiary forms of primary production offers little prospect except for tea; yet even this industry has lagged. Until Government actively intervened in 1956 it failed to attract capital in significant quantity, and it retains substantial problems of costs so that Government subvention of one kind or another may well be a continuing necessity.

ACKNOWLEDGMENTS

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THE ISOLINE OF NINETY FROST-FREE DAYS IN CANADA*

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THIS paper seeks to present a generalized demarcation of the land area of Canada wherein the average frost-free period, when frost is taken as occurring at the temperature of 32° F., is less than 90 days. The reasons for attempting the demarcation are two.

(1) Nearly 40 years ago, Reed wrote, though with specific reference to the United States, "There is very little agriculture, except that based upon wild hay and grazing, where the average season between killing frost is less than 90 days."[1] He was thus specifying an observed "limit," whether imposed by low temperature alone or by some combination of low temperature with economic, social, and historical influences, upon the cultivation of land—at least in the United States as of the early twentieth century. While other descriptions of limits or barriers to land cultivation associated with low temperature have been advanced, notably—though with specific reference to grain production—that of availability of an accumulation of daily mean summer temperatures above 10° C. in the amount of 1500°–1600° C., the world seems not to have been mapped on the basis of any except that of 90 days free of frost. If, therefore, one seeks to study empirically crop production throughout the world in the neighborhood of some physical-economic limit or barrier associated with low temperature, the isoline of 90 frost-free days appears to afford a feasible approach.

(2) In Canada, however, this isoline is either poorly, incompletely, or inconsistently indicated, or not indicated at all, in atlases where one might expect or hope to find it. As yet no Canadian atlas attempts to show it, although a recent study[2] gives an isoline pertaining to 80 days free of 32° F. frost and (east of the Rockies) another pertaining to 100 days; and an older Canadian atlas shows a map, though for the Prairie Provinces only, of areas free of "killing" frost, defined as 29° F., for less than 90 days.[3] Van Royen's recent (1954) atlas of the agricultural resources of the world[4] does not deal with frost-free zones or "growing seasons," nor does Hainsworth's graphic summary of world agriculture of 1949,[5] or Finch and

*The writer's thanks are due to Mr. P. Stanley King and Mrs. Patricia Theimer of the Food Research Institute for preparation of the maps.

[1] W. G. Reed: "Frost and the Growing Season," Section I of U. S. Dept. Agr., Off. Farm Management, *Atlas of American Agriculture. Part II. Climate*, 1918, pp. 10–11.

[2] C. C. Boughner, R. W. Longley and M. K. Thomas: *Climatic Summaries for Selected Meteorological Stations in Canada, Vol. III, Frost Data*, Canada Meteor. Div., Dept. Transport, 1956, pp. 12–13.

[3] W. B. Hurd and T. W. Grindley: *Agriculture, Climate and Population of the Prairie Provinces of Canada*, Canada Dom. Bur. Stat., 1931, p. 20.

[4] William Van Royen, in co-operation with U. S. Dept. Agr., Bur. Agr. Econ.: *The Agricultural Resources of the World*, Vol. 1 of *Atlas of the World's Resources*, New York, 1954.

[5] R. G. Hainsworth: *A Graphic Summary of World Agriculture*, U. S. Dept. Agr. Misc. Pub. 705, October 1949.

Baker's older (1917) geography of world agriculture.[6] While Bartholomew's recent atlas[7] presents a map of "Length of Growing Seasons" that marks off for lower Canada the season "Under 3 months," it is on an inconveniently small scale, lacks definition of "growing season," and seems to include far too little territory in that zone as judged by areas free of 32° F. frost for less than 100 days according to the official Canadian mapping of 1956. On the other hand, the *Great Soviet Atlas of the World* of 1937,[8] which presents for the whole world an isoline of the 90-day frost-free period (among others), by the same criterion includes far too much area in Canada in the zone free of frost for 90 days and less. It appears that Trewartha observed this, for his world map of 1954, adapted from the Soviet map,[9] and entitled "Average length of the frost-free period, or growing season, in days," assigns considerably less territory in the Prairie Provinces to the zone free of frost for less than 90 days than does the Soviet source.

Isolines designed to demarcate regions free of frost for stated periods ought to be, and for Canada can be, based upon specific observations of temperature at specific points of latitude and longitude. Since the search here is for an isoline of "normal" or "average" 90-day frost-free period, observation-station records covering only a few years ought not to be used in its determination. The official Canadian publication[10] gives average length of frost-free period at nearly 1300 points of observation in Canada (not including Yukon Territory and the Northwest Territories), but at 47 per cent of the stations the number of years entering into the determination of the average frost-free period is less than 14 years. In the search for the isoline of the 90-day frost-free period in Canada, I exclude these stations, both to economize cartographic labor and to enhance the probable representative quality of the averages. An initial choice of 25 years of observation as the criterion of probable dependability excluded so great a number of stations that it seemed wiser to encompass more observations. A second choice of 15 years excluded a few stations with 14 years of observation that were located at high latitudes in areas where stations were very sparse, and it seemed advisable to include them as buttressing the evidence in that region.

Figures 1 and 2 show, for the Prairie Provinces and all of Canada eastward, the locations of all points of observation for which the official source gives length in days of the period free of 32° F. frost in averages compassing at least 14 years. Each point with an average frost-free period above 90 days is shown by a hollow circle; each point with an average frost-free period of 75–89 days by a cross; and each point with an average of less than 75 days frost-free by a solid circle. The isoline purporting to separate areas frost-free respectively for less and for more than 90 days is of course my freehand fitting of a generalized curve to the data. It is designed, while preserving a maximum of generality, to include on its warmer side a maximum of points where the frost-free period exceeds 90 days and on its colder side a maximum of points where the frost-free period is shorter. At the same time it seeks so far as

[6] V. C. Finch and O. E. Baker: *Geography of the World's Agriculture*, U. S. Dept. Agr., Off. Secretary, 1917.

[7] John Bartholomew: *The Advanced Atlas of Modern Geography*, London and New York, 1950, p. 19.

[8] *Great Soviet Atlas of the World*, Moscow, 1937, Pl. 35.

[9] G. T. Trewartha: *An Introduction to Climate*, New York, Toronto, and London, 1954, p. 46.

[10] Boughner, Longley and Thomas, *op. cit.*

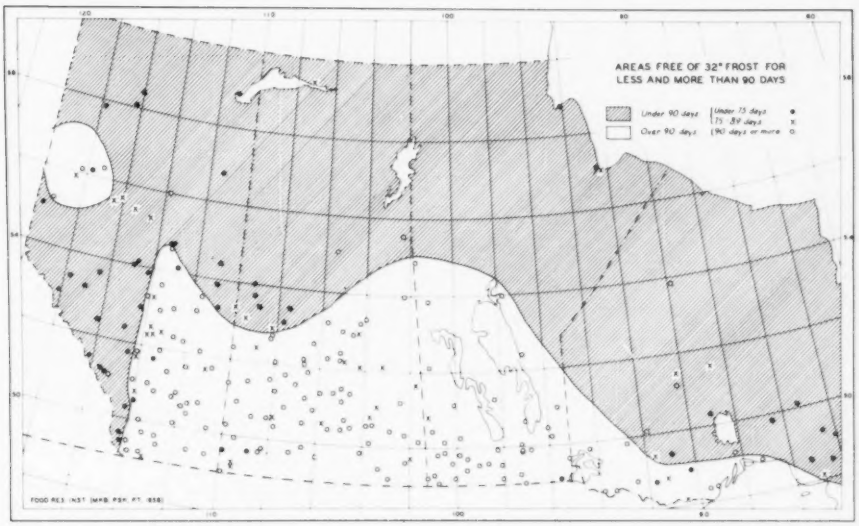

FIG. 1. Position of the 90-day frost-free line in Alberta, Saskatchewan, Manitoba, and western Ontario.

possible to avoid depiction of "islands" of low temperature in the warmer zone and of high temperature in the colder zone.

The generalized isoline is not difficult to establish in Alberta and western Saskatchewan, where observations are both numerous and rather easily contrasted as to position in relation to the longer and shorter frost-free periods. But in Figure 1 east of about the 106° meridian in Saskatchewan, the geographical scatter of observations is great and the contrast not clearly defined, until one reaches Ontario east of about the 88° meridian. It may well be that in the stretch of territory between the 106° and 88° meridians there is a general tendency for bias of observations toward the longer frost-free period, for in this area relatively many stations are located close to fairly large bodies of water and thus exceptionally subject to temperature-moderating influence. In so far as they are associated with early settlements, it is also possible that their locations are in sheltered spots such as might well have been chosen partly because they were relatively sheltered. On the basis of these hypotheses I draw the line of demarcation considerably farther south than would appear reasonable in view of about half a dozen widely scattered observations of frost-free periods exceeding 90 days lying to the north. The three most northerly of these observations in Figure 1, it may be noted, represent averages for 14 years only.

Very likely the procedure ignores some islands of under-90-day frost-free period in the warmer zone and possibly also some islands of over-90-day frost-free period in the colder zone. Of the latter, perhaps (as suggested in Figure 2) there is a small one in eastern Ontario around the intersection of the 82° meridian and the 50° parallel, although the two stations there (Smoky Falls and Abitibi Canyon) yield averages based on less than 20 years and

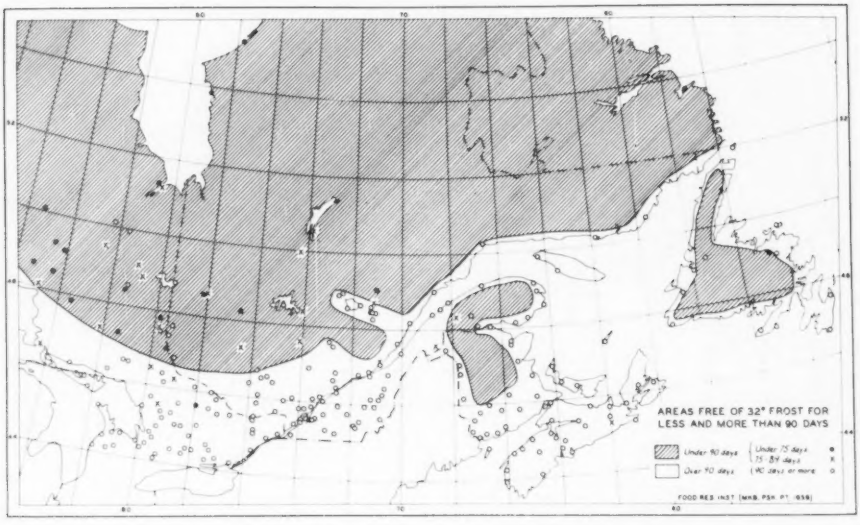

FIG. 2. Position of the 90-day frost-free line in eastern Ontario, Quebec, and the Eastern Provinces.

one may guess that their locations may be somewhat sheltered. Another small island of frost-free period exceeding 90 days may exist in the zone indicated as of the shorter frost-free period between the 80° and 78° meridians, at the boundaries of Ontario and Quebec. While other such islands may exist in the cold zone, the evidence presently available seems hardly to support the probability, although accumulation of more evidence with passage of time and with increase in the number of points of observation may later demonstrate their presence. One large island surrounded by the cold zone is the Peace River country of western Alberta; this is indicated (Fig. 1) as a detached portion of the warmer zone.

Within the warmer zone, islands of territory characterized by frost-free periods of less than 90 days probably lie (1) in western Alberta around the intersection of the 114° meridian and the 52° parallel; (2) in the extreme southwestern corner of Saskatchewan where, in the Cypress Hills, elevation is relatively high; (3) in eastern Saskatchewan mostly between the 104° and 102° meridians and the 51° and 53° parallels; and (4) in western Ontario north of the Minnesota border between the 92° and 90° meridians. To indicate these islands would depart farther than seems desirable from the principle of achieving maximum and yet sufficiently valid generalization.

The problem of drawing a line of demarcation at once sufficiently generalized and yet not departing too far from the probabilities is well indicated in Figure 2, between the 74° and 70° meridians. One must certainly encompass the Lake St. John–Saguenay River Basin in the warmer zone. It is practically surrounded by land lying at considerably higher altitudes and of course the length of frost-free period may in general reflect either high latitude or high altitude, or a combination of the two. While observations are lacking in the territory immediately south of the Lake St. John region, the high elevations there, notably in Lauren-

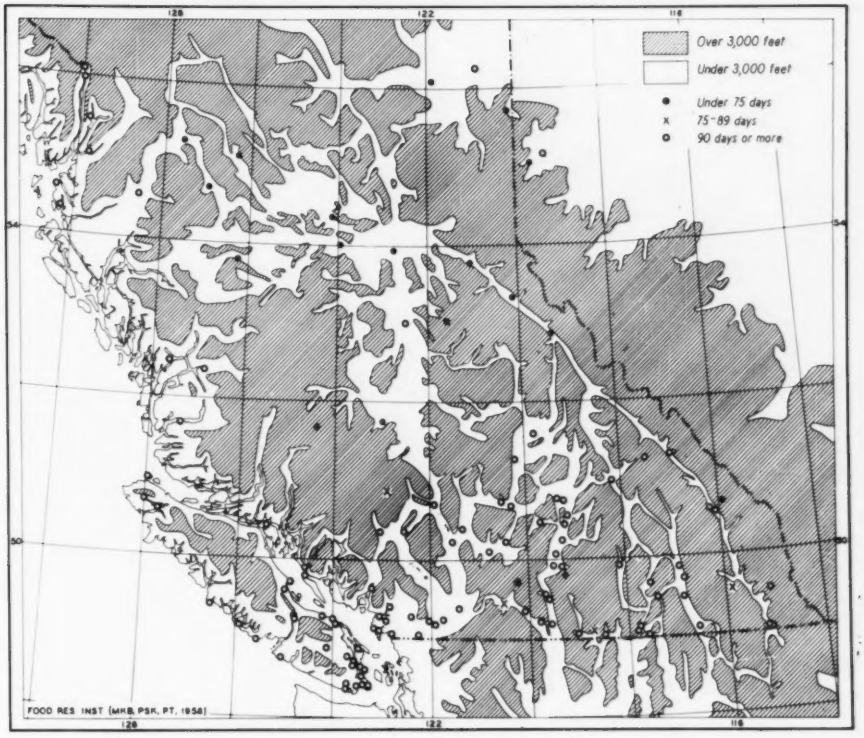

FIG. 3. British Columbia: elevations over and under 3000 feet and location of observation stations.

tides Provincial Park, create a strong presumption that a tongue of the colder zone protrudes southeasterly nearly to the St. Lawrence River. East of the 70° meridian on the long northern shore of the St. Lawrence River and Gulf, there are only six points of observation; none at all exist inland from the coastal fringe. But, with elevations increasing rather abruptly from that fringe, it seems clear that the warmer zone in this territory encompasses only the coastal fringe itself. Similarly to the south, the relatively high elevations appear to warrant demarcation of two colder zones, islands surrounded by warmer territory, in Newfoundland, the Gaspé Peninsula, and the northern inland portion of New Brunswick.

Figure 3, showing British Columbia, is designed to emphasize the nature of the problem involved in differentiating in a generalized way the warmer from the colder zone in terrain varying greatly in elevation within rather short distances, wherein at the same time there are fairly numerous observations of temperature at low elevations but relatively very few at high elevations. Here the hatched area represents all land above 3000 feet in elevation. As the map shows, the number of points of observation lying in elevations above 3000 feet is small indeed.

No substantial problem is presented, however, by the lack of higher-elevation observations north of about the 51° parallel. Except for a coastal fringe at

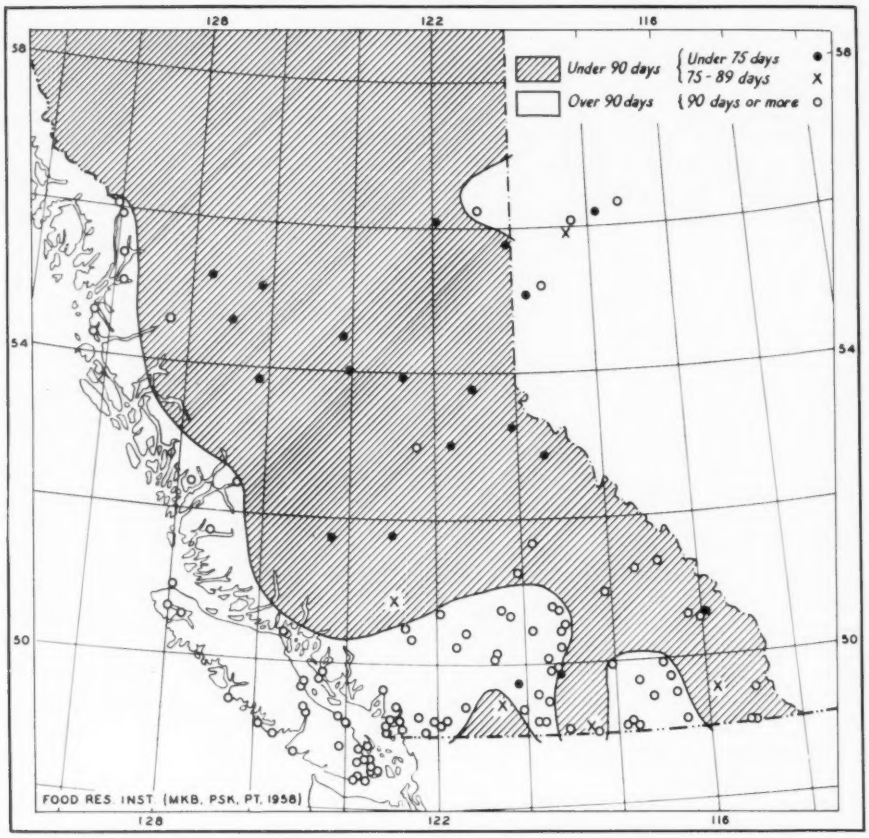

FIG. 4. British Columbia: areas free of 32° frost for less and more than 90 days.

low elevations, and a portion of the Peace River country, one may justifiably generalize to the extent of marking off all of British Columbia north of that parallel as falling in the zone of frost-free period less than 90 days in length.

Below the 51° parallel, it appears inevitable to sacrifice either generality to precision, or precision to generality. Perhaps a sufficiently accurate demarcation could be made by classifying all land above 3000 or 4000 feet in elevation as in the zone free of frost less than 90 days, and all land at lower elevations as free of frost more than 90 days. As the map shows clearly enough, to take this course would be to present a complicated and detailed rather than a highly generalized differentiation.

Figure 4 makes it clear that precision has been sacrificed to generality. North of the 51° parallel, all British Columbian territory except the coastal fringe and the Peace River enclave is assigned to the colder zone. The coastal isoline separating the colder from the warmer zone roughly follows the western fringe of elevations above 3000 feet, as may be seen by comparison of Figures 3 and 4. South of the 51° parallel, the

procedure was merely to enclose as lying in the warmer zone all the points of observations recording frost-free periods of more than 90 days except for a few scattered outlying ones. Presumably far too much land area is here included in the warmer zone, if one may judge by the prevalence of high elevations as shown in Figure 3, especially in upper Vancouver Island and north of the national border along the 50° parallel from the coast eastward nearly to the 119° meridian.

The results of the inquiry for Canada as a whole are brought together in Figure 5, Section B, and compared with the Russian mapping, reproduced as faithfully as possible, in Section A. If the mapping of the less-than-90-day frost-free zone of Canada in Section B is reasonably dependable, the conclusions appear warrantable (a) that in British Columbia the Russian mapping includes too little territory in this colder zone; (b) that in the Prairie Provinces eastward to Lake Winnipeg it includes too much; and (c) that east of Lake Winnipeg to the Atlantic it again includes too little.

It is now feasible to relate the Cana-

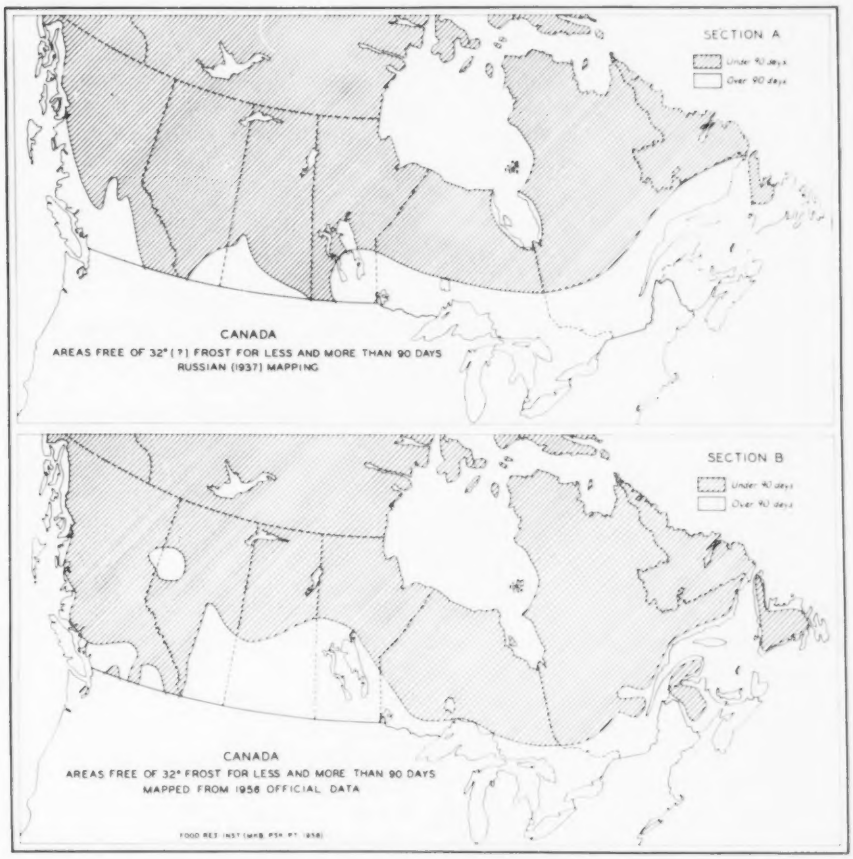
SECTION A
Under 90 days
Over 90 days
CANADA
AREAS FREE OF 32° (?) FROST FOR LESS AND MORE THAN 90 DAYS
RUSSIAN (1937) MAPPING
SECTION B
Under 90 days
Over 90 days
CANADA
AREAS FREE OF 32° FROST FOR LESS AND MORE THAN 90 DAYS
MAPPED FROM 1958 OFFICIAL DATA

FIG. 5. Comparative mappings of Canadian areas free of frost for less and more than 90 days

dian zones averaging less and more than 90 days free of frost, established strictly (though with generalization) on the basis of weather records, to geographical distributions pertaining to cultivation of land. It would be feasible at this point to present maps showing relationships between the isoline of 90 days free of frost and the acreages (1951) of a substantial number of specific crops, including wheat, barley, oats, hay, and potatoes.[11] In the interests of brevity, however, I present only two relationships of a more general character, those between the isoline and population distribution (Fig. 6, Section A), and between the isoline and the distribution of land in farms as this may be reflected in a map of generalized types of farming (Fig. 6, Section B). The two distributions of Figure 6 suggest, if imprecisely, the distribution of land in cultivation (under the plow), while presumably overstating its geographical spread. Comparison of the two distributions shows that small population groups exist within the colder zone in places where there is no land in farms. This would be expected, considering the existence of such occupations as hunting, trapping, fishing, fur trading, mining, lumbering, policing, soldiering, and servicing railways that pass through desolate regions; one would also expect the aggregate of such population groups to be relatively very small, as clearly it is. However, one sees that land in farms, and people residing on such land, extend somewhat into the colder zone, most notably in Alberta and western Saskatchewan but also along the Quebec-Ontario border and, patchily, in British Columbia. Some of this intrusion may merely reflect the presence of uncultivated forest or pasture land in farm land.

Examination of official maps of specific crop acreages (not shown here) demonstrates clearly enough, by count of dots on the official maps, that in British Columbia the scattered islands of land in farms in the colder zone represent—so far as they represent cultivated land at all—cultivated acreages overwhelmingly in tame hay. Its acreage exceeds that of all other crops—mostly oats—in a ratio of at least 10 to 1. Of the islands of crop acreage in the colder zone around the Quebec-Ontario border, three-fourths of the acreage is tame hay and the bulk of the balance is oats. No wheat and very little barley are found in either of the two regions mentioned. The great bulk of the cultivated land clearly goes to the crops that give an economic yield even when seed does not ripen. Green oats are, of course, usable as hay, and in both areas tame hay is the dominant crop on plowed land. In effect so small are the absolute acreages of grain crops in these two regions, and so small are the ratios of acreage in them to total farm acreage, that one is justified in regarding the presence of grain crops as exceptional, even negligible.

It is different with the extension of farm land into the colder zone of western Saskatchewan and Alberta. Here the cultivated acreage (by count of dots) in grain crops and starchy roots is not only substantial—over 3 million acres—but also exceeds that in tame hay in a ratio of nearly 10 to 1. Clearly the cultivation of grain is well established in this portion of the Canadian zone of less than 90 frost-free days. It was rather well established fully 30 years ago, judging by an official map of land in field crops in 1926.[12]

[11] Dot maps of these and other distributions appear in Canada Dom. Bur. Stat., Census Div., *A Graphic Presentation of Agriculture, 1951 Census*, Ref. Paper 63, 1956.

[12] Hurd and Grindley, *op. cit.*, p. 30.

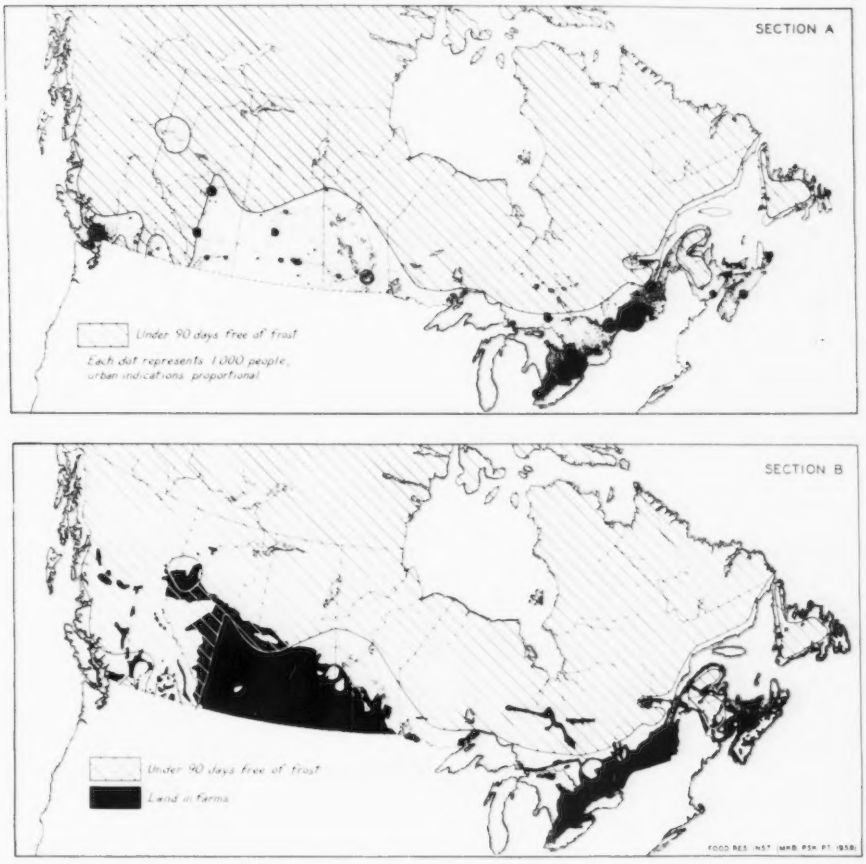

FIG. 6. Distribution (1951) of Canadian population and land in farms in relation to areas free of 32° frost for less and more than 90 days.

To conclude: on the basis of the evidence given above, Reed's statement, with only minor qualification, holds for Canada; one may properly say that there is little agriculture, except that based upon wild hay and grazing, where the average season between 32° F. frost is less than 90 days. Yet two aspects of this inquiry are of major interest. First is the appreciable use of land for grain crops, in western Saskatchewan and Alberta, in a zone free of frost and not alone for 90 days or less but even into a zone where in the main the frost-free period of the year seems clearly to average less than 75 days (Fig. 1). Second is the almost complete absence of grain crops from wide stretches of land, adjacent to the 90-day isoline, where the frost-free period is in excess of 90 days, both in British Columbia and in all of Canada east of central Saskatchewan. Thus it seems probable that under some circumstances of climate and economics the isoline of 90 days free of frost is

not a barrier to full-fledged arable agriculture based on grain and the effective barrier may run as low as or a little below 75 days frost-free, whereas under other climatic or economic circumstances an isoline of appreciably more than 90 days free of frost might mark the effective barrier.

I do not propose to attempt here, however, to explain these phenomena. Soils and terrain, as well as temperatures and economic circumstances, may be involved. It seems advisable first to examine crop intrusions into the colder zones of high latitudes in other continents and into the colder zones lying in lower latitudes but at high altitudes. Such zones exist in the United States, and, according to Russian mapping, in the southern reaches of Andean South America and in central Asia.

TRANSPORTATION FACTORS AFFECTING LOCATIONAL DECISIONS

Maurice Fulton and L. Clinton Hoch

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AMONG the many considerations influencing the location of manufacturing facilities, transportation factors are the least understood and the most frequently misinterpreted. This reflects, in part, the complexity of freight rate structures and the extensive interplay of transportation charges, raw material costs, and marketing factors.

Transportation and Economic Theory

Generally, the economic theory of location has been a somewhat neglected area. The few economists treating it, however, have recognized the importance of transportation. As background, and at the risk of oversimplifying their systems of thought, we may quickly review how some of these theorists have stressed "transfer costs" or freight charges:

Von Thünen,[1] in 1875, formulated his location theory around the cost of transportation and land rent. In an attempt to explain why a particular agricultural product is grown on a given plot of land, he substituted land cost for transportation cost (and vice versa) until he obtained the least-cost combination. While Von Thünen's study was limited in scope, most modern theorists still recognize an inverse relationship between freight cost to markets and land costs.

Alfred Weber,[2] in 1909, based his theory of factory location on transportation cost, labor cost, and agglomerating forces. Weber showed a surprising misunderstanding of freight rate structures by assuming uniform costs per ton-mile. In cases where the "cost of transfer" is the only important locational factor, he concluded that—(1) where a single raw material is used in the manufacture of an article without loss of weight in the process, location can be at the source of the material, at the market, or at any point in between; (2) if a weight-losing material is used, it is cheaper to carry on the manufacture at the source than to transport it to market, as the finished product is lighter; and (3) if a ubiquitous material is used, then location should be at the market, since the material is universally available.

Despite his errors and omissions, Weber made a significant contribution by carefully delineating transport and non-transport costs. He recognized that freight costs are *not* the dictating factor in all location problems, and that the optimum location represents that point where computed transport costs and non-transport costs yield minimum

[1] J. H. von Thünen: *Der isolierte Staat in Beziehung auf Landwirthschaft und Nationalökonomie*, 3 vols., Hamburg and Rostock, 1826–1863. For a more recent and accessible exposition, see R. T. Ely and G. S. Wehrwein, *Land Economics*, New York, 1940.

[2] Alfred Weber: *Ueber den Standort der Industrien*, Part I, Reine Theorie des Standorts, Tübingen, 1909, translated by C. J. Friedrich as *Alfred Weber's Theory of the Location of Industries*, University of Chicago Press, Chicago, 1928.

total unit charges. His treatise is the basis of our modern distinction between raw material-oriented, market-oriented and labor-oriented industries.

Holmes,[3] in 1930, discussed the complexities of freight rate structures and tariffs. However, he made no attempt to apply these findings to economic theory, other than to emphasize the strong locational influence of raw materials.

Until as late as 1948, therefore, when Hoover's *Location of Economic Activity* was published,[4] the literature on economics of plant location had disregarded the actual characteristics of freight rates. Hoover introduced the fact—well known to freight traffic men—that rates do not increase proportionately with distance. He recognized the influence of heavy terminal costs which are independent of the length of haul. He also considered the reality of divergent cost influences of carload and less-than-carload shipments in his modifications of the early location analyses.

These theories, largely of German origin, treat transportation and other costs as *separate* factors influencing locational decisions. They emphasize selections of the least-cost location, suggesting that the new plant will be able to sell its output at the prevailing market price with greater profits than competitors who are less fortunately situated with respect to a given market.

This "classical" approach cannot be accepted by modern theorists seeking to interpret our monopolistic-competitive economy. Nor can it be accepted by the American business man seeking to locate his new production facilities.

Today, the least-cost location represents more than an opportunity to obtain the largest sales volume with greatest return at a given market price. *The location must also permit the company to undersell its rivals in key markets and place a wider area under its control.*

Transportation, therefore, can no longer be viewed as a separate and distinct locational factor, as in the Weberian analysis. Freight rates and quality of transportation service are interdependent variables within the entire framework of production and marketing objectives.

TRANSPORTATION AND STRATEGIC PLANT LOCATION

Strategic plant location is the use of the manufacturing site as a means of control over economic areas rather than simply the least-cost base of production. Its objective is to exclude competitors from selected markets.

This purpose can be accomplished by application of several advanced locational techniques. Only the transportation methodology is of pertinent interest here.

Assume that a manufacturing firm wishes to expand its share of the national market for a given product which is sold on "F.O.B." mill terms by all producers. This objective could be partially accomplished by establishing a branch plant in a key market area where competitive pressures are strongest. However, strategic plant location may yield a greater long-term advantage.

First, the freight advantage zone for each competing producer (including the firm itself) is plotted on a map. This study, coupled with freight rate comparisons, will reveal the area having *highest* freight rates from all present producers. That region should prove to be the most fruitful location for a new branch plant—provided its market

[3] E. G. Holmes: *Plant Location*, 1st edit., New York, 1930.

[4] Edgar M. Hoover: *Location of Economic Activity*, 1st edit., New York, 1948.

is sufficiently large to sustain an economical production unit.

In effect, the new plant will re-define the effective marketing zones for its nearest competitors. Slight shifts in actual location of the new facility may capture important markets along the borders of the zone.

The growth of manufacturing facilities on the Pacific Coast is an excellent example of this approach. Producers in that region tend to exclude competitors attempting to ship from the eastern and central states at a freight disadvantage.

The principle of strategic plant location is most clearly illustrated by industries utilizing "F.O.B." pricing systems. However, it applies almost universally:

(a) Where products are sold on an "equalized" basis with the competitor closest to the customer's destination, increased freight absorption lowers the mill net for distant producers—who tend to surrender the regional market to the new plant in that area;

(b) Where products are sold on a "delivered" or uniform price to all customers, the strategically-located plant reduces the profitability of sales in its region for distant producers—who tend to become less aggressive in the market dominated by the new plant; and

(c) Where an industry utilizes a zone pricing system or the basing point system, "phantom freight" is added to the new plant's profit margin—placing it in a favorable competitive position in the industry.

In some instances, of course, the area of greatest freight penalty for all present producers will represent insufficient market potential to support full-scale manufacturing operations. Strategic plant location techniques then turn "inward" to capture a group of key markets by *proximity*.

This process systematically attacks the competitor's freight advantage. A sub-regional market is selected which meets the following tests: (1) ample demand to sustain an economic production unit; and (2) location of the prime competitor's plant at one *edge* of the selected market zone.

Freight rates from the competitive plant to representative key cities in the sub-region are determined. In turn, each rate is projected from that shipping point through all stations having an equal rate to the destination under examination. A series of intersecting "equalization" lines are constructed in this manner, and a territory is clearly defined which will offer a freight advantage over the competitive plant to the entire sub-regional market.

Least-cost analysis is applied to determine the best location within this favorable zone, effectively capturing the market for the new plant to the exclusion of the former competitor as well as any future competitors.

TRANSPORTATION AND ECONOMIES OF SCALE

Our mass-production technique is based upon the premise that the worker specializing in a repetitive operation becomes expert in this small task and greatly expands his output—lowering unit costs. Lower prices in turn increase the demand for his product, leading to the installation of special machinery and still further reductions in unit costs.

The extent to which specialization may be conducted is limited by the size of market which can be reached at sufficiently low cost to enable the mass producer to compete with local, small-scale

competitors. Theoretically, then, *the extent to which it is profitable to expand the scale of a given enterprise in a particular location depends upon a balancing of the economies of mass production against the increased cost of transportation to a wider market.* (*Note*: Another limitation may involve increased costs of drawing raw materials from more distant suppliers to meet production demands.)

Obviously, any decrease in outbound transportation costs will enhance the size of the enterprise by expanding its profitable marketing zone. Conversely, any increase in outbound freight costs will tend to contract the size of its geographical market and, in turn, limit production.

Since 1946, freight rates have been spiralling upward at a slightly higher rate than production costs for many industries. Any shrinkage in the profitable marketing zone, however, has usually been offset by increased demand within the service territory. Adverse trends may be hidden by the general prosperity, but few manufacturing executives are unaware that transportation expenditures now represent a larger proportion of the sales dollar.

General freight rate increases have another adverse effect upon specialized mass-production plants. *They widen the differential between short-haul delivery costs of the small-scale local competitors and the long-haul rates applicable from larger plants in distant cities.*

One example will serve to illustrate this important point. Assume that the large company can produce a given product for $7.00 and that shipping charges to Podunk are $3.00, or a total delivered-to-customer cost of $10.00 per unit. A small local competitor must offer his product for $10.00 (due to higher unit production costs), and adding a drayage charge of $1.00, his delivered price must be $11.00 per unit. The larger firm dominates the Podunk market by offering this product $1.00 cheaper than the small-scale competitor.

Now, applying a general freight rate increase of 75 per cent, the long-haul rate from the large plant becomes $5.25 and the new drayage cost from the small plant is $1.75. This local firm can now deliver the product in Podunk at $11.75, while the larger competitor's product remains unsold at $12.25 per unit.

These considerations, applied to thousands of competitive relationships, explain (in part) the trend toward regional duplication of production facilities and the decline of older manufacturing centers. Corollary effects are the decline in rail carloadings and the growth of short-haul motor truck traffic.

TRANSPORTATION, SHIFTING MARKETS, AND THE GROWTH OF REGIONAL PRODUCTION

We have observed how general freight rate increases, applied as percentage inflations, tend to destroy the competitive advantage of large-scale specialized producers. Many companies faced with this problem have maintained their dominant position in the industry by establishing regional production plants.

Unquestionably, the impetus behind the growth of regional duplication in manufacturing facilities has involved more than general freight rate increases. This trend directly reflects the radical alterations in United States market patterns which have occurred during the past few decades and may be expressed as follows: (a) the increased birth rate and declining death rate have inflated our population beyond expectations; (b) economic prosperity has increased per capita demand for goods of all kinds; and (c) the shift in population toward the west has been accelerated.

California, now ranking in second place in population among the states, has more than doubled its consumer purchasing power since 1929. Almost one-third of the nation's population now resides west of the Mississippi River.

Manufacturers of consumer goods welcome the continued growth of their market potential but they view the geographic shift of population with concern. Westward migration tends to increase the cost of serving national markets from the traditional manufacturing centers—particularly New England and the Atlantic Seaboard. This problem is aggravated by the upward spiral in transportation rates.

It is axiomatic that lowest outbound freight costs prevail from a point at or near the center of markets. For many firms manufacturing consumer goods, the center of markets coincides with the center of United States population, situated in southeastern Illinois.

Actual experience indicates savings of at least 10 per cent in outbound freight costs for manufacturers of consumer goods who relocate all production facilities from the Atlantic Seaboard (or the Pacific Coast) to a community in the central zone. Furthermore, the shortest total distance to all customers prevails at the center, minimizing average delivery time to the national market.

Still greater reductions in outbound transportation costs can be achieved under the regional production program. It also offers considerable improvement in delivery time, consistent with customer demands upon vendors to maintain complete stocks within the overnight delivery zone.

Some interesting trends are developing in the chronological order of establishing regional production facilities. For many firms, the first one or two locational decisions are dictated by competitive pressures, while the desire to further reduce freight costs appears to influence subsequent plant locations.

Let us consider a typical branch plant program for an eastern manufacturing firm. Faced with growing competition from Midwest producers, the company establishes a branch unit in the Central States to equalize the service and cost advantages of the local manufacturers in the region.

Freight rate considerations influence the next stage of planning. Encouraged by the favorable result of the Midwestern plant, the company will seek to further reduce its annual freight bill by establishing a plant on the West Coast, with the next logical unit in the Southwest or Southeast. Increased sales potentials rather than growing competition weight these decisions.

RAW MATERIAL—ORIENTATION

Nature, in her arbitrary fashion, has limited the sources of raw materials available for use in manufacturing processes. Before they can be utilized, these materials must be carried to the processing location—whether it is at the mine head or thousands of miles away.

This type of transportation is sometimes called "geographically-necessitated." (*Note*: The same term is also applied to the movement of finished products from a remote raw material processing point to ultimate consumers.) It contrasts with "specialization-necessitated" transportation which we previously discussed in connection with the distribution of products from a large-scale or mass production plant.

Whether an industry will locate close to raw materials or at some distance from these sources is largely a question of: (1) the relationship between the rates prevailing on raw materials and those applied to movements of the finished product; (2) the extent of weight loss incurred in the manufacturing proc-

ess; (3) the amount of unmarketable by-products or scrap; and (4) the quantity of fuel consumed in the process.

Freight rates generally progress with stages of fabrication. This reflects the *value* principle in rate making and alterations in the other transportation characteristics of the product.

Some processed materials are bulky in proportion to weight and costly to handle. Others are not only bulky but also require special handling to prevent damage, spoilage, or other deterioration.

Conversely, where the finished product is of relatively low value, loads easily, and is of high density, it may take a rate not greatly exceeding that of its component raw materials.

With this background, let us consider some typical "raw material orientations" of typical manufacturing processes:

(1) Low quality mineral ores are usually smelted or concentrated near the mine since they contain much unsalvagable waste.
(2) Cement, glass, and basic chemicals are heavy fuel users and site selection is frequently oriented to low-cost sources of gas.
(3) Steel processing involves substantial weight loss. A source of cheap, high quality fuel is usually the greatest locational attraction rather than ore and fluxing limestone, since the input of coal is nearly a complete loss.
(4) Agricultural processors locate close to the raw material producing areas due to waste consideration; e.g., beet sugar refining, cotton ginning, saw mills, etc.

MARKET ORIENTATION

Improved transportation has greatly reduced the cost of moving materials to markets and has also increased the speed of distribution. Yet there are certain industries where the product is of sufficiently low unit value so that transfer costs still are a significant proportion of the delivered price. In these instances, location immediately adjacent to consuming markets is the governing locational factor.

Some of the industries which cannot successfully exist outside the immediate vicinity of local markets are bakery products, ice cream manufacture, artificial ice, bottling of milk, and job printing shops.

Other industries, carrying extraordinarily high freight rates as compared to the cost of assembling raw materials, must also locate near their markets. These manufacturing processes include tin cans, barrels and drums, and corrugated containers.

Another group of products may be sold over a broader market area but the influence of nearby competitors and the size of the market govern location as well as the size of the production unit. These products include cement, brick, fertilizer, storm sash, and prefabricated houses.

LOCATIONAL EFFECTS OF CHANGES IN RATE STRUCTURE

Carriers have it within their power to initiate rate structures which can exert significant influences on location. They can, in some measure, perpetuate existing but badly located industries to the exclusion of similar plants in more favorable locations. Conversely, they may publish low commodity rates or extend special transit privileges which will foster new industrial developments.

No single policy has had a greater effect upon locational decisions than "transit privileges." Rates for short distances are commonly on a higher ton-mile basis than those for longer distances. Consequently, the combination

of two or more local rates between two points is usually higher than the single through rate applying between the same two points on a given commodity.

The rate structure, therefore, would tend to foster the location of plants at either the raw material source or at the market rather than at the higher cost intermediate location. This situation can be completely reversed, however, by the granting of transit privileges.

The first transit privilege on record appears to have been offered in 1870 at Nashville, Tennessee. In 1909, the Wheeling and Lake Erie Railroad published rates granting the privilege of stopping steel in transit at Canton and Toledo for fabrication permitting the establishment of new fabricating plants in those cities in direct competition with Pittsburgh producers.

We now accept the transit privilege as part of the normal transportational geography affecting locational decisions. The privilege has been extended to include the items shown in Table I.

TABLE I

COMMODITIES WITH TRANSIT PRIVILEGES

Commodity	*Transit privileges*
Grain	Milling, inspection, mixing, grading, sacking, and storage
Lumber	Manufacturing and further improvements
Marble and granite	Finishing
Lead bullion and zinc ore	Refining
Livestock	Grazing and fattening
Iron and steel products	Fabrication
Cotton and hay	Compression
Butter, eggs, dairy products, and dressed poultry	Concentration
Miscellaneous manufactured products	Storage

Transportation is a key consideration for certain specific types of manufacturing activity.

Steel

Semi-finished steel prices reflect a very large sum for transportation charges, including the cost of assembling raw materials and fuel as well as delivery cost from mill to customer. Raw material assembly costs may exceed 30 per cent of the total cost of manufacturing pig iron. Delivery of finished steel involves freight costs which average more than 10 per cent of its base price.

The steel industry is a heavy user of coal and has been more strongly influenced by the availability of fuel than any other single factor. Location near a high grade of coking coal available at low cost is essential to the large scale development of this industry. However, mills in the Gary–South Chicago District are an important exception. Although their assembly costs are somewhat above those of the Pittsburgh-Wheeling District, their nearness to western markets tends to counterbalance this disadvantage.

Chemicals

The need for large supplies of coal or natural gas has influenced many chemical plants to locate close to the sources of these fuels. Proximity to coal, for example, has traditionally been an important factor in the location of plants manufacturing rayon. The concentration of petrochemical industries along the Gulf Coast reflects the delivery of cheap natural gas as well as the availability of water transportation.

Glass

Glass manufacture has been traditionally located close to supplies of natural gas because of its large fuel requirements. The proximity of glass sand deposits has been another important attraction.

Changing relationships between raw material assembly costs and delivery charges on glass containers have encouraged establishment of modern glass plants close to markets rather than glass sand deposits. This reflects, as

well, the increased efficiency of long distance pipeline transportation of gas.

Cotton Textiles

The shift of cotton textile production from New England to the South is *not* explainable by savings in transportation costs of raw materials. While the Southeastern mills save 20 to 34 per cent on freight costs for cotton supplies compared to the New England mills, this saving represents only 0.3 to 0.7 per cent of total manufacturing costs.

Meat Packing

The spread between livestock rates and those applying to dressed meats is a matter of almost continual controversy before the Interstate Commerce Commission. Unquestionably, the growth of packing at centers west of Chicago and the resurgence of packing in the East have significantly reduced Chicago's share of the total.

Flour Milling

The relationship between rates on grain and flour have had a significant effect on the location of flour milling activity. General freight rate increases have definitely caused a decline in production at Minneapolis and have contributed to the rapid rise of Buffalo as a flour milling center.

The milling-in-transit privilege has tended to equalize freight burdens permitting the Eastern mills to compete with the Middle West. However, the wide application of the transit privilege is tending to eliminate the special advantages which have been obtained by a few milling locations and cities in almost every geographic region are now competing for the milling trade.

TRANSPORTATION AND GENERAL MANUFACTURING

Unfortunately, some industrial traffic managers are didactic in their approach to plant location problems. We have emphasized the relative importance of transportation charges in the preceding discussion but freight rate influences on site location vary considerably from industry to industry. They are a paramount consideration when selecting a location for a new blast furnace or a cement mill, but in direct contrast, a 100 per cent variation in total freight costs could be completely disregarded in the choice of sites for a manufacturer of precision instruments, fountain pens, etc. In other words, freight costs must be viewed in their proper perspective among the many factors affecting locational selection.

It is in the investigation of raw material assembly costs that the greatest number of errors occur in comparative freight rate calculations. Too frequently, the traffic department will calculate rates from present supply sources, rather than alternate regional sources which would be available to the new plant. As a result, prospective locations may be heavily burdened by raw material assembly costs and then eliminated from consideration by error.

Another common mistake on calculation of raw material assembly costs is to disregard terms of sale. Comparative freight rates on raw material movements may be academic, since all suppliers in that industry may offer the commodity on an equal delivered price, regardless of plant location. In other instances, suppliers may equalize freight costs with the closest competitors.

TRANSPORTATION COSTS AND LINEAR PROGRAMMING

One of the most difficult problems in plant location investigation is to balance inbound and outbound freight costs in order to determine the point offering lowest aggregate transportation costs.

Until recently, this involved a long, tedious operation of trial and error.

Now, through the development of linear programming techniques, there is promise that the mathematical choice of the best solution may soon be developed. The transportation method of linear programming, as its name suggests, has been developed for problems involving a number of shipping sources and a number of destinations. With the modifications now under consideration at Fantus Factory Locating Service, this programming technique may yield lowest delivered-to-customer aggregate costs for comparative locations. These calculations, of course, will involve the use of the latest electronic computers.

NEW DIRECTIONS FOR TRANSPORTATION EXECUTIVES

The growth in our national economy and the corresponding increase in the size of manufacturing companies has introduced new complexities into the transportation geography for these firms. Each new plant location decision for multi-plant companies further complicates these problems.

Accordingly, the traffic executive is being consulted to an increasing degree concerning the influence of new plants on the distribution pattern, the total freight bill of the company, customer service, etc. The traffic executive is now concerned with inter-plant movements of semi-finished materials, stop-offs for partial loading and unloading, consolidation of shipments from various plants, mixed carrier arrangements, storage-in-transit privileges, etc.

Simultaneously, the traffic executive is faced with the problem of long-term reduction of freight costs for his company. In plant location decisions, top management must be apprised of the influence that new facilities will have upon this objective.

In some instances, it can be anticipated that the opening of new plants and warehouses will tend to reinforce economics favoring private fleet operation. In other instances, strategic location of new facilities will permit wider use of contract carriers since new two-way movements may be created.

These alterations and others may demand changes in purchasing, sales, production, and other top management policies. In plant location decisions, therefore, the new direction for transportation executives involves a general growth in new responsibility.

LAND USE MAPPING IN SUDAN

J. H. G. Lebon

Dr. Lebon contributed to the Land Utilization Survey of Britain in 1930–1935, and his report on Ayrshire forms Part I of "The Land of Britain." He has been Professor of Geography in the University of Khartoum since 1953.

IN September, 1955, during the Symposium on Natural Resources, Land and Population in Tropical Africa held at Makerere College, Kampala, Uganda, Professor L. Dudley Stamp asked the author of this article to address a meeting on land use maps. In the brief talk which was thereupon prepared and delivered,[1] it was stated that no land use maps for any part of Sudan existed; but certain local surveys had been executed, not primarily of land use, but which might serve as the basis of such. The general inference was pessimistic, for it then seemed quite impracticable to attempt to produce land use maps for a territory of nearly a million square miles.

However, the author, on his return to Sudan, gave further thought to the question, and decided to apply, experimentally, the World Land Use Classification to the country.[2] Certain problems emerged, which will be stated later in this article, with their solutions; but, what was more important, it was realized that for a scale of 1:2M or 1:4M, it would be possible to draw a generalized and provisional map, showing land use types, by using certain published maps of vegetation types (to reveal the extent of unimproved grazing land),[3] of such important bioclimatic factors as the limit of the tsetse fly (which constitutes a barrier to the southward extension of grazing),[4] as well as the local surveys discussed at the Symposium.[5] Also—and this was the last door which needed to be opened—it was realized that the topographic series at 1:250,000,[6] the largest-scale series depicting the whole of the country, though essentially the product of reconnaissance survey, having been compiled from route sketches, local surveys, and the like, mainly by administrators and army officers in the early years of the Anglo-Egyptian Condominium (1899–1955), provides, on the whole, a reliable representation of inhabited areas. The early administrators needed to know, above all, where the people they ruled were to be found when they were "on trek," and thus they were especially careful to locate all villages. Now nearly all cultivated

[1] International Geographical Union, *Natural Resources, Food and Population in Inter-tropical Africa*, Report of a Symposium held at Makerere College, Uganda, September, 1955, edited by L. Dudley Stamp, London, 1956, pp. 70–77.

[2] S. Van Valkenburg: "The World Land Use Survey," *Econ. Geogr.*, Vol. 26, 1950, pp. 1–5.

[3] Sudan, Vegetation Map, 1:4,000,000, Sudan Survey Department, Khartoum, 1955.

[4] *Natural Resources and Development Potential in the Southern Provinces of Sudan*, Khartoum, 1954, Fig. G. Cf. D. J. Lewis: "The Tse-tse Fly Problem in the A.-E. Sudan," *Sudan Notes and Records*, Vol. 30, 1949, pp. 179–211.

[5] *The Equatorial Nile Project and Its Effects in the A.-E. Sudan*, being the Report of the Jonglei Investigation Team, Khartoum, 1954, especially Vol. IV, Map 7 (Predominant Vegetation Types), and Maps E 1–14. Sir Alexander Gibb and Partners, Estimation of Irrigable Areas in the Sudan, 1954.

[6] Topographical Map of the A.-E. Sudan, 1:250,000, Sudan Survey Department, Khartoum, 167 sheets, 1929–1955.

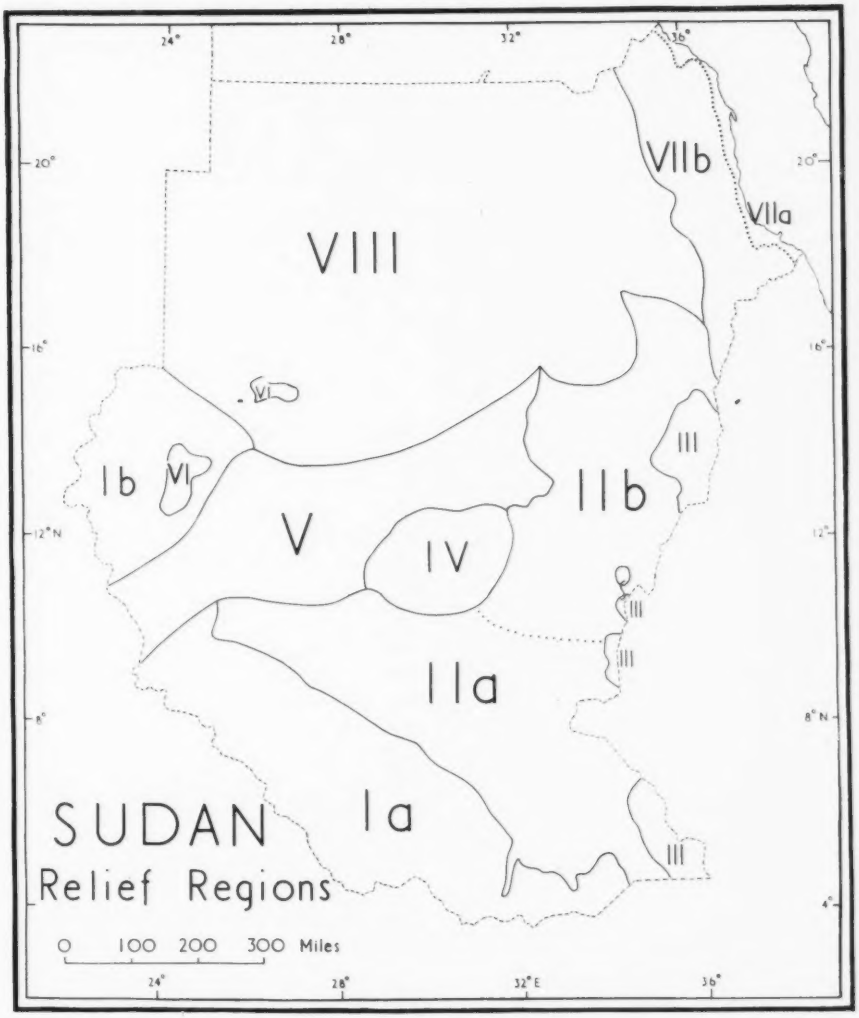

FIG. 1. Relief regions of Sudan. For names and descriptions of regions see text. (Intersections of parallels and meridians with the border are shown at intervals of 4° both on this map and on Figure 2, but are numbered only on this map.)

land falls into categories 4b or 7f(i) of the World Land Use system (*i.e.*, land rotation or shifting cultivation), and occurs within a limited distance of villages, usually five to seven miles. Accordingly, when a map on a small scale is being compiled, the chief cultivated areas of the country may be delimited approximately by enclosing all areas within this distance of settlements.

The way was therefore open to compile a map on a scale of 1:3M, *i.e.*, the largest scale for which a map has been printed on one sheet for the whole

country. This (first) provisional map for Sudan was exhibited at the Congress of the International Geographical Union held at Rio de Janeiro in August, 1956.

Meanwhile the author had occasion, for other reasons, to consult the air photograph collections of the Survey Department, Sudan Government, Khartoum. This Department, since the end of the War of 1939–45, has owned copies of the trimetrogon air photographs taken by the U.S.A.A.F. in 1942–3, when the trans-Africa supply route to the Middle East was being organized, and it was imperative to provide more accurate maps for air navigation. The photographs in this collection number about 60,000, and they portray the whole of the country north of latitude 8° N., except the extreme northwest. Since 1950, the Survey Department has itself been engaged in vertical photography. Some large tracts, including areas south of the 8th parallel, in the Nile swamps, the Red Sea hills, northern Kordofan, and southern Darfur, have thus been photographed; and the total of Sudan Government vertical photographs (to April, 1957) is about 113,000.[7] It was discovered that trimetrogon, as well as vertical photographs, permitted highly accurate plotting of cultivated areas; and it was, therefore, decided to attempt, also, to map on the normal scale prescribed by the World Land Use Inventory, *viz.*, 1 to 1 million. Only one sheet of this series (El Fasher, ND 35) has been revised from air photographs and published; but it includes significant portions of the main cultivated and pastoral zones of central Sudan. The task of inserting land use boundaries on this sheet was begun in the autumn of 1956, and finished in March, 1957, after about 8200 photographs had been inspected. Minor revision of its extreme southwest, from vertical photographs which had meanwhile been produced, was undertaken in August, 1957.

The completion of the El Fasher 1:1M sheet enabled the Provisional 1:3M map to be revised for about one-eighth of the country; and the author decided also to use trimetrogon photographs for the purpose of revising those features which he regarded as least satisfactory, *viz.*, the delimitation of the desert border and the transitional zone of desert-sparse grazing (denoted by the symbol 6a′-9). This was accomplished in September, 1957; and he was able also to effect further minor revision in the center and south from population maps which Mr. K. M. Barbour had been preparing at University College, London, using the results of the First Population Census of Sudan, 1955–1956. Thus, eventually, was produced the Revised Provisional Land Use Map of Sudan, on the scale of 1:3M, of which the map accompanying this article (Fig. 2) is a generalized version.

It is expected that this (revised) map will be published on a scale of 1:4M, together with the El Fasher 1:1M sheet, and the author is writing a memoir which will embody a lengthier analytical account of the two maps. In this short article, the facts disclosed by the Revised Provisional Map will be briefly discussed.

The Essentials of Climate, Natural Vegetation, and Relief

Sudan is typically African. It is a tableland, upwarped in some places, down in others. Quite locally, hills and mountains rear out of the monotony. The transition from a near-equatorial climate on the southern frontier (annual rainfall about 60 inches

[7] Sudan, Air-Photo Cover, 1:4,000,000, Survey Department, 1957. The *Annual Reports* of the Survey Department from 1949 to 1956–1957 may also be consulted.

and dry season two to four months) to the desert (annual rainfall almost zero) at about 20° N., through the gradations of the tropical continental climate, in which rainfall and length of rainy season vary inversely with latitude, is only locally distorted by relief, perhaps to the greatest extent in the extreme southeast, which, situated as it is in the angle between the Ethiopian and the East African uplands, is notably dry for its latitude. Concomitantly, the equatorial rain forest, extending across the frontier from Belgian Congo in the southwest, merges into semi-deciduous forest with tall grass and this in turn into acacia scrub with tall grass, sparse acacia with short grass, semi-desert, and desert.

On the basis of relief and geological formations, a number of physiographic or relief regions may be discerned (Fig. 1). These are demarcated on the map and distinguished by Roman numerals to avoid confusion with land use notation; and a description of each region will now be given, *seriatim*.[8]

I. The Western and Southern Plateaus. Here, along the upwarping separating the Nile Basin from those of the Congo and Lake Chad, the exposed basement complex has been dissected by a dendritic network of main and tributary streams. The larger valleys often have alluvial floors. The interfluves, in the southwest, are usually capped by laterite, and here the name Ironstone Plateau is applied (Ia). Inselbergs are not uncommon, rising 500–1000 feet above the general level of 1500–2500 feet. Near the frontier with Uganda are the higher massifs of the Imatong Mountains, the Dongotona Hills, and other smaller uplands, which, perhaps, should be regarded as relief sub-regions. In western Darfur, beyond an extension of Region V, archaean rocks reappear and display similar features of relief and soil (Ib).

II. From Juba to beyond Khartoum, the Bahr-el-Jebel and the White Nile cross an alluvial plain, which has been accumulated in a pear-shaped, downwarped area. On either hand, in the south, the rivers from the Ironstone Plateau (to the west) and Ethiopia (to the east) contribute their loads to the continuing alluviation. Such is the degree of aggradation that slopes are too small to permit rivers to carry their full discharge in the rainy season to the Nile, or to allow rainfall to reach watercourses. Thus south of about latitude 10° N. the whole plain becomes a swamp during the rainy season (IIa). During the dry season, the excess of water disappears, and as a whole the region is dry, fire-swept, and waterless; but there are permanent marshes along the main rivers and in certain other localities. North of latitude 10° N. rainfall is less, and only local waterlogging occurs during the short rainy season (IIb). Also, the plain is diversified by inselbergs, which were not quite submerged in the deepening alluvium.

III. The frontier, in principle, separates the Sudanese plains from the Ethiopian mountains; but has been demarcated so that certain detached massifs, spurs and foothills, of which the most important are the Boma Plateau and the hilly environs of Gallabat, fall within Sudan.

IV. West of the White Nile is another area in which the basement complex is exposed, and from which inselbergs and massifs arise, often abruptly: collectively known as the Nuba Mountains. The largest of these measures about 45 by 15 miles, and the highest summit reaches 4691 feet (Jebel Tema-

[8] Sudan, 1:2,000,000, in 3 sheets, Survey Department, 1954–1955. Sudan, Geological Map, 1:4,000,000, with a complementary edition showing "extensive superficial deposits," Survey Department, 1949.

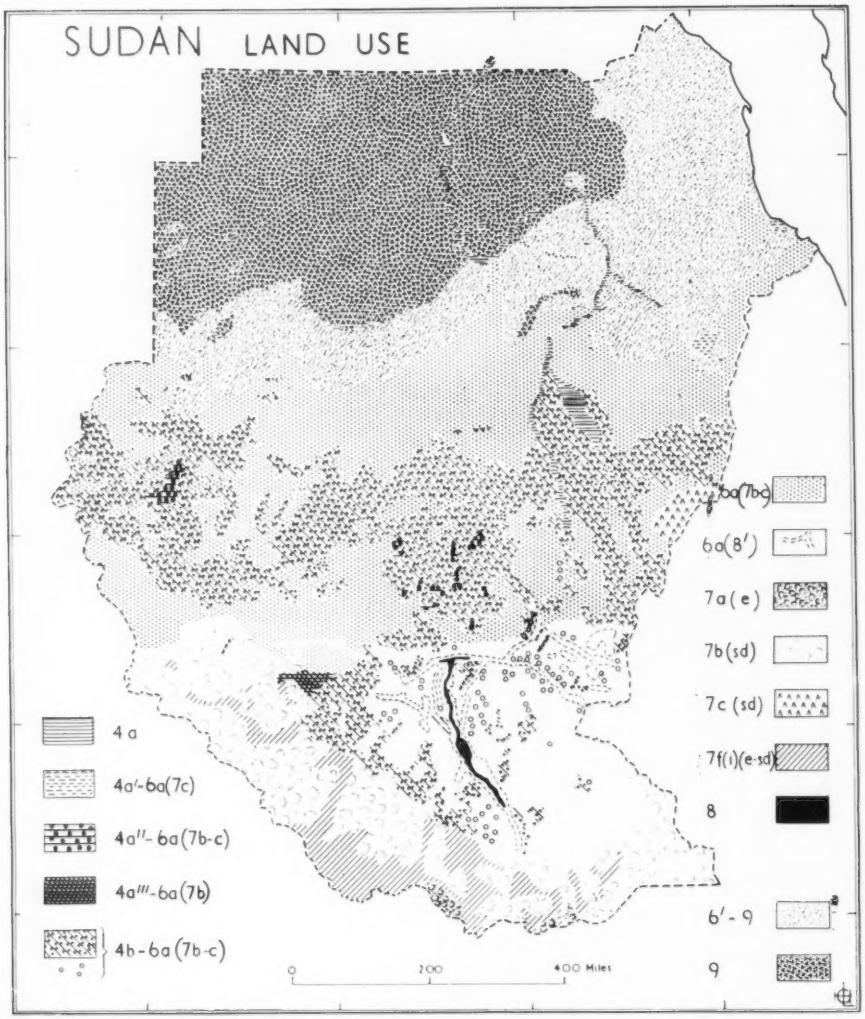

FIG. 2. Land use of Sudan. Numbers and letters of legend have reference as follows:

4a. Continual and rotation cropping.

4a′–6a(7c). Cropping on flush-irrigated land, with used unimproved grazing in scrub.

4a″–6a(7b-c). Terraced cultivation in mountains, with used unimproved grazing in semi-deciduous forest (with grass) or scrub (with short grass).

4a‴–6a(7b). Continual cropping with some unimproved grazing, in semi-deciduous forest with tall grass.

4b–6a(7b-c). Land rotation with used unimproved grazing, in semi-deciduous forest with grass, or scrub with short grass. (The small circles locate areas too small to contain the regular ornament.)

6a(7b-c). Used unimproved grazing, in semi-deciduous forest with grass, or scrub with short grass.

6a(8′). Used unimproved grazing in seasonal swamp (mainly tall grass, but with some scrub and scattered trees). The broken lines outline the late dry-season grazing lands.

7a(e). Dense (closed) evergreen forest.

7b(sd). Open semi-deciduous forest (with tall grass).
7c(sd). Semi-deciduous scrub (with short grass).
7f(i)(e–sd). Evergreen and semi-deciduous forest with shifting cultivation.
8. Swamp.
6a′–9. Mainly desert, with some used unimproved grazing. ("a" omitted from symbol on map.)
9. Unproductive land (desert).

ding). Each inselberg or massif is fringed by a pediment veneered by detritus of varying texture; and the larger watercourses flow in silty or clayey flood plains.

V. North and west of the Nuba Mountains, and reaching the White Nile between Jebelein and the Sixth Cataract, is a region mainly of sand dunes, formed during a (presumably) Pleistocene dry period from the weathering of the great outcrop of Nubian sandstone to the north, and now fixed by acacia trees and grass. These Dunes at their deepest (along the boundary between Kordofan and Darfur), are without surface drainage; elsewhere, watercourses are attenuated and imperfect.

VI. West of the Dunes, and rising from the basement complex in central Darfur, is the volcanic massif of Jebel Marra, with which may be associated the detached massif to the northeast, known as the Meidob hills. The summit of the Jebel Marra (9980 feet) is on the rim of an extinct volcanic crater containing two lakes. Adjacent are high plateaus of lava and tuffs, dissected into badlands. Detritus from these volcanic uplands has descended in the flood waters of torrents and has formed silty, fertile piedmont plains.

VII. The Red Sea littoral is low, and consists of raised coral reefs and active dunes (VIIa); but inland, at a distance of from 10 to 25 miles from ocean water, is a dissected fault-line escarpment, compound in places, marking the western edge of the Red Sea rift valley. This escarpment rises to between 2000 and 4000 feet, and is succeeded, in turn, by the broken and rugged Red Sea hills (VIIb), which attain over 7000 feet, though most summits are between 3000 and 5000 feet. Some rather lower parts are more plateau-like.

VIII. North of the Dunes and west of the Red Sea hills is desert; called, east of the Nile, the Nubian Desert, and to the west, the Libyan. Both deserts are diversified, and contain inselbergs, rocky massifs of archaean crystalline rocks, buttes and mesas of Nubian sandstone, rocky or gravelly plateaus and great expanses of active dunes, especially west of the Nile and north of latitude $18\frac{1}{2}°$ N. On the margins are a few intermittent watercourses which, however, owe their existence to rains falling to the south and southeast.

LAND USE TYPES AND THEIR DISTRIBUTION

Several categories of land use specified in the classification of the World Land Use Inventory are unrepresented in Sudan, or appear to a very limited extent. On the scale of the present map (Fig. 2), category 1 (settlements) cannot be delineated, because there are no large urbanized tracts such as are to be found in industrialized countries, and even the capital, Khartoum, and the adjoining Omdurman, occupy only a few square miles. Horticulture (category 2) and tree crops (category 3) occur only locally. The small plots of onions and other vegetables grown under irrigation from the Nile near Khartoum and Atbara; the small market-gardens watered from wells at Kassala; the government-owned citrus fruit orchards in some irrigated basins of Northern Province, and smaller orchards planted

by peasants; the clusters and strips of date palm close to the River—could only be represented on a scale of about 1:5,000. Improved permanent pasture (category 5) is again absent.

Slightly more extensive, but still small in proportion to the country as a whole, are areas of continual and rotation cropping (type 4a), of several kinds. Along the Blue and White Niles, north of latitude 12° N., and continuing northward along the main Nile to the Egyptian frontier, are areas watered artificially by flow or by pumping. The larger units, irrigated by pump, or by gravity from the Sennar Dam, can be delineated from the 1:250,000 maps. Where farming depends upon the *shaduf* or the Persian water-wheel, the strip of cultivated land must be exaggerated in width to be shown on the present map; but this has been done to indicate that tillage is almost unbroken from Khartoum to the frontier. For such irrigated areas, the symbol 4a is used.

It may be concluded from the foregoing statements, and correctly, that types of land use characteristic of middle latitudes (and more densely settled lands) have barely intruded into Sudan. All areas so far specified are in the northeast, and may be regarded as extensions, along the Nile routeway, of types of agriculture dominant in middle latitudes. And their tropical equivalents are also absent, or almost absent, from the country. In short, the prevailing types of land use in Sudan, outside the unproductive desert of the northwest, type 9, are those characteristic of the humid African tropics. As already stated, land used for crop production is in land rotation, type 4b, or shifting cultivation, type 7f(i). The remainder, largely, is used unimproved grazing land, type 6a. Smaller in proportion, but nevertheless of great extent in so large a country, are forested lands, in the far south, which are uninhabited or used only for the production of timber (types 7a and 7b).

Two important facts must now be noticed. First, these dominant types of cultivation and pastoralism do not cause replacement of existing vegetation, but only its modification. Both land rotation and shifting cultivation rely upon regeneration of the natural vegetation as the means to renew fertility after cropping. The patches of cultivation are like islands in a sea of reviving forest or scrub; though unlike most islands they change in position and size from year to year. Secondly, most of the country, between the desert in the north and the northward limit of the tsetse fly in the south (to be correlated roughly with the northern edge of the Ironstone Plateau), is used by nomadic and semi-nomadic pastoralists who travel far during their customary seasonal migrations seeking pasture and water. Moreover, pastoral use of land comprises most areas of land rotation as well as those lying outside, because the stock of cultivators grazes upon much of the stubble and regenerating vegetation, though not upon all. On the scale of the present map, and by the methods of compilation used, it is not possible to distinguish between cultivated areas which are also used for grazing (the greater fraction), and those which are not (chiefly those which are managed as *hariq* or by the grass-firing system).[9]

These two facts in turn led the author to certain adaptations of the World Land Use system of classification and symbols. First, the symbol 4b was combined with 6a, because of the superposition of pastoral uses upon land rotation. Secondly, and because no permanent replacement of natural vege-

[9] J. D. Tothill, edit., *Agriculture in the Sudan, 1948*, pp. 292–293.

tation results from these methods of cultivation and grazing, the original type of natural vegetation has been appended to certain subsidiary 4a types, to 4b, 4b-6a, and 7f(i). This, it is believed, enhances the value of the map, since it indicates, to those familiar with African vegetation, the nature of the regenerating plant mantle. The combined symbols thus resulting have been considered as separate categories of land use for the purpose of delimitation. It will be shown later that there is a further advantage to be derived from this expedient, for Sudan, because areas over which different types of pastoralism prevail can be distinguished.

If the map (Fig. 2) is now scrutinized, it will be observed that land rotation prevails in a zone extending across the country from east to west, between about latitudes $10\frac{1}{2}°$ and $14\frac{1}{2}°$ N. This zone is usually called the Central Rainlands. It crosses the northern Clay Plain (relief region IIb), includes much of the Dunes (IV) and the Nuba Mountains (V), envelops the Jebel Marra (and indeed penetrates to the higher altitudes therein), and continues across western Darfur to the frontier with French Equatorial Africa. The northern limit is imposed by aridity near the annual isohyet of about eight inches. The southern limit corresponds with an annual rainfall of about 25 inches and a rainy season lasting four to five months, during which the predominating clay soils are waterlogged and domestic animals suffer severely from biting flies. The staple of the Central Rainlands is millet, in one of two forms, the common millet (*Sorghum vulgare*) or bulrush millet (*Pennisetum typhoideum*) (Burm.) (the latter especially in sandy soils), both of which can flourish where rainfall is light and intermittent.

The length of rotation varies. It is shortest on lands near villages, called *bildat*, on which cultivation is almost perennial, with but brief resting periods. On *hariq* lands (mainly in relief regions IIb and IV) one or two years of cropping are succeeded by fallow for two to four years. In gum arabic "gardens" tillage for two to six years is followed by regeneration for six to twelve years during which *Acacia Senegal* and *A. Seyal* grow freely and are tapped.[10]

Farther to the south, it will be observed, land rotation is practiced on smaller areas, near the main rivers and close to the Ironstone Plateau in the southwest, within relief region IIa. These areas are slightly higher than the clay plains generally, and hence are usually above the otherwise ubiquitous swamp of each rainy season. To these islands the Nilotic tribes—Dinka, Shilluk, Nuer, Murle—retreat as waters spread over most of their land, and here they break ground and sow crops of millet.[11]

To the prevalence of land rotation as the type of cultivated land use north of the tsetse fly belt and away from the Nile, three local exceptions may now be noticed. (1) Among the torrents which descend from the northern Ethiopian highlands are two, the rivers Gash and Baraka, which have formed silty deltas, the former northwest of Kassala, the latter on the Red Sea coastal plain near the Eritrean frontier. Both torrents have been brought under control, and their deltas used in part for growing cotton. For areas thus subject to controlled flush irrigation and annual cultivation, the symbol 4a′ 6a(7c) has been used, though it should be realized that the actual areas cultivated vary from year to year, and depend upon the size and character of the flushes, as well

[10] J. K. Jackson and M. K. Shawki: "Shifting Cultivation in the Sudan," *Sudan Notes and Records*, Vol. 31, 1950, pp. 210–222.

[11] *The Equatorial Nile Project*, Vol. 1, p. 280.

as changes in level produced by deposition of silt.[12] (2) In the Nuba Mountains[13] and the Jebel Marra,[14] Nuba and Fur peoples have long practiced types of terraced agriculture, the latter in conjunction with shifting cultivation and irrigated gardens from small perennial streams. The separate areas thus cultivated are too minute to be delineated on the map; but the massifs within which these types of land use occur are indicated by the symbols 4a″ 6a(7b) or 4a″–6a(7c) for the Nuba Mountains, and 4a″–6a(7b) for the Jebel Marra. (3) At the extreme southwest of the clay plains, near Aweil, western Dinka are very numerous, and are crowded onto land just above flood level along the lower Lol and Kyom rivers, and on islands in the seasonal swamps. They have insufficient land to practice land rotation; and cultivate perpetually, maintaining fertility by tethering cattle and thus ensuring that the soil is impregnated with excreta.[15] Congestion doubtless has thus required of the people to transform land once (it may be inferred) used on a rotation basis to continual cropping, from 4b to 4a‴–6a(7b).

On the Ironstone Plateau of the far southwest, and to a more limited extent east of the Bahr-el-Jebel and close to the frontier with Uganda, is a zone, which, untouched by the hand of man, would bear either rain forest (7a) or semi-deciduous forest with tall grass (7b). Much of this zone, west of the Nile, is virtually uninhabited as a consequence of the depredations of slave raiders from the north during the 19th century. Where it is inhabited, by a variety of Negroid tribes, shifting cultivation is the norm; although an attempt has been made in the last decade to resettle the Zande people, who occupy land close to the frontier with Belgian Congo between Yei and Tembura, near roads and on demarcated plots on which, it is intended, permanent homesteads shall be established and land rotation eventually replace shifting cultivation.[16] It is too soon to be certain that the economy has thus been changed; and so the area has been classified as 7f(i), which is appropriate to the traditional mode of life. East of the Bahr-el-Jebel, permanent settlements have been founded under the guidance of the administration at the foot of isolated hills, from which descending surface and sub-surface water maintains not only domestic supplies but also keeps the soil moist after rather light and erratic rains. Adjacent cultivation is on the basis of land rotation rather than shifting cultivation, but the areas are too small to be shown on the map.[17]

Used unimproved grazing land (6a) is the most extensive of all land use categories. It stretches from the desert in the north to the northern limit of the tsetse fly in the south, over about 12° of latitude. This great tract may be subdivided into five zones.

[12] C. H. Richards: *The Gash Delta*, Bulletin No. 3, Ministry of Agriculture, Khartoum, 1950.
[13] J. D. Tothill, *op. cit.*, pp. 298, 832, 836–837.
[14] *Ibid.*, pp. 867–872.
[15] *Ibid.*, pp. 294–295, 652.

[16] V. E. F. Eyre, D. M. Ramsay, and T. N. Jewitt: *Agriculture, Forests and Soils of the Jur Ironstone Country of the Bahr-el-Ghazal Province, Sudan*, Bull. No. 9, Ministry of Agriculture, Khartoum, 1953; P. de Schlippe: *Shifting Cultivation in Africa, The Zande System of Agriculture*, 1956, especially pp. 15, 17, 37–39, and c. 13; "The Zande System of Agriculture," *African Soils*, Vol. 3, 1954, pp. 52–63; "Hedge Strip Farming, A Plan for Zandeland," *Sudan Notes and Records*, Vol. 36, 1955, pp. 6–36; S. G. Willimot: "Cultivable Land and Land Use in Equatoria Province, Sudan," *Malayan Journal of Tropical Geography*, Vol. 8, 1956, pp. 40–50; S. G. Willimott and K. R. Anthony: "Agricultural Research and Development in the South-West Sudan," *Tropical Agriculture*, Vol. 34, 1957, pp. 239–48 and Vol. 35, 1958, pp. 16–33; "A study of Soil Fertility in Zandeland, Sudan," *Empire Journal of Experimental Agriculture*, Vol. 24, p. 75 *et seq.*
[17] J. D. Tothill, *op. cit.*, pp. 906–908.

1. The plant mantle is not continuous along the margin of the desert. Indeed, it is most discontinuous within a crescent-like area 80–150 miles wide, where most of the surface is bare rock, sand, or gravel; but patches of scrub and grass occur, edible to camels, especially in the gravelly or silty beds of intermittent watercourses, which are numerous in and to the west of the Red Sea hills (relief region VIIb). On the higher plateau of northern Darfur, the scanty rains nourish a type of grazing known to the Arabs as *gizu*[18] consisting mainly of the grasses *Aristida ciliata* (Desf.) and *Indigofera arenaria* (Rich.), which, according to Arab belief (to some extent confirmed by scientific research) are more nutritious dessicated than when growing. *Gizu* also includes more succulent plants and small shrubs which enable camels to survive without recourse to drinking water till quite late in the dry season. Patches of this type of grazing have been observed by travellers and noted on 1:250,000 sheets as far north as latitude 19. But desert is predominant; and to extend type 6a beyond the limit of more or less continuous vegetation would be misleading. Accordingly a combined index (6a′–9) has been devised and applied where desert predominates, but is interspersed by patches and strips of *gizu*. In terms of the categories of vegetation types, the 6a′–9 crescent corresponds with the desert scrub; but it has been demarcated more accurately, after recourse to air photographs, than on previously published maps.
2. To the south is a zone of continuous or near-continuous vegetation, of the acacia-short grass type, characterized by a variety of genera, though *Aristida* is perhaps the commonest. Rainfall is too small for cultivation, except where run-off, in the valleys of watercourses or at the foot of rocky hills, locally concentrates water in the soil. This zone provides the chief pastures for Arab camel-owning nomads, who move northwards towards the desert during the rainy season, and in general southwards during the dry season.[19] These tribes also rear sheep and goats.
3. Farther south, again, are the Central Rainlands, already described, in which small areas of 6a interdigitate with larger areas of 4b–6a. Nomadic herding merges here with the stock—cattle, goats, sheep, asses and some camels—of sedentary village cultivators. Some tribes are partly nomadic and partly sedentary. There are complicated customary arrangements regulating the use of water sources and pastures at different seasons and by different groups. Broadly speaking, however, the animals belonging to nomads do not come near villages, where grazing is reserved for the cultivators' stock. Around all larger villages, intense grazing by animals, as they pass to and from more distant pastures, and firewood cutting, have produced local deserts generally called "village perimeters." Around towns, these devastated and unlovely stretches are even bigger, and only at a few points, e.g., En Nahud and El Obeid, have control and replanting been attempted.

[18] *Ibid.*, pp. 378–379, 670.

[19] *Ibid.*, p. 651.

4. Again to the south is a zone which is mainly uncultivated and without a settled population; broad in southern Darfur, southwest Kordofan, and between the Nuba Mountains (IV) and the White Nile; somewhat discontinuous south of the Nuba Mountains and on the Clay Plains (IIb). In this zone, the Dunes (V) and the piedmont alluvia of the Nuba Mountains merge into clay plains, except east of the White Nile, where there is clay unrelieved. In general, this zone may be deemed to be the grazing area of the cattle-owning (Baggara) peoples during the dry season.[20] As the rains cease, they move southwards, seeking water and fresh herbage, until, after February, they are located along the Bahr-el-Arab (or even beyond), the Machar marshes and the river Sobat. When the rains begin, men and beasts move northward quickly to escape biting flies and, in the clay areas, mud. Thus, during the rainy season, this zone is virtually uninhabited, apart from some Dinka, whose pastoral practices conform to those of Nilotic tribes generally (*vide infra*).
5. The southern Clay Plains (relief region IIa) are the domain of the Nilotic tribes, also cattle-herders, but owning different breeds from the Baggara, and practicing different methods of rearing. In the rainy season, which in these latitudes lasts for six or seven months, when so much of their homeland is a swamp, men and animals retreat to higher and drier patches, or to the edges of the Ironstone Plateau, lingering on the way to enable their cattle to feed on new grass produced chiefly by the species *Hyparrhenia rufa*. They tether their cattle at night in their rainy-season settlements, lighting dung fires to keep insects at bay, and smearing their own bodies with ashes.[21] Also, they till the soil (*vide supra*). As the rains cease, they return slowly across the drying swamps, which they fire, to destroy the rank growth of the rainy season, now dead, and to encourage a limited regrowth from the moisture in the soil. Eventually they reach the flood plains of the perennial rivers, adjacent to the permanent marshes, accessible because of the normal fall of the rivers and bearing a growth mainly of the *Echinochloa* spp. of grass. Here they remain until the rainy season is heralded and the annual cycle recommences. These late dry-season pastures are outlined on Figure 2 by broken lines.

[20] *Ibid.*, pp. 668–670.

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[21] *Ibid.*, pp. 651–652, 669–670. Cf. *The Equatorial Nile Project*, Vol. 1, c. 4, secs. 2 and 3.

THE CITRON IN THE MEDITERRANEAN: A STUDY IN RELIGIOUS INFLUENCES

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THE citron, or *Citrus medica*, is today, commercially, the least important of cultivated citrus fruits.[1] It is used primarily for the production of candied citron peel, and the leaves and blossoms of the tree provide essential oils used in the manufacture of perfume.[2] But despite the citron's minor commercial role the fruit has a twofold significance for the economic geographer. Historically, the citron is important inasmuch as it was the first fruit of the genus citrus to be cultivated in the Mediterranean. There it was introduced and spread by the Jews, to whom the fruit is necessary for the ritual celebration of the holiday of the Feast of Booths. The citron, moreover, was in all probability responsible for the initial introduction of oranges and lemons to the Mediterranean, for whose early cultivation there we have evidence.[3] But of greater geographic significance is the illustration offered by the history of the citron of the role which religion may play in shaping the landscape and in determining regional and interregional economic relations. The citron is certainly an exceptional example of the religious factor at work; the present day location, and, historically, the shifting of areas of citron production in Mediterranean lands can be explained to a large extent in terms of religious needs and fashions.

[1] It is currently of such minor importance in world trade that the Foreign Agricultural Service of the United States Department of Agriculture does not compile data on the world trade in citron.

[2] H. Harold Hume: "Citrus Fruits and Their Culture," 2nd edit., New York, 1907, pp. 59–60; J. Henry Burke: "The Citrus Industry of North Africa," *Foreign Agriculture Report No. 66*, U. S. Dept. of Agric., Washington, 1952, p. 118.

Appearance and Significance of Citron

The spread of citron through the Mediterranean coincided with the growth of Jewish communities in the Mediterranean Diaspora. The extent

[3] The Jews, who became leading arboriculturists and horticulturists in the first four centuries A.D., were familiar with varieties of citrus other than the citron and it is reasonable to believe that they transferred the skills developed in growing citron to the production of other citrus fruits with which they were familiar, and whose requirements were very close to those of the citron.

On the early spread of citron to the Mediterranean see Pauly-Wissowa: "Real Encyclopaedie der Classischen Altertumswissenschaft," Stuttgart, Vol. III, 1899, pp. 2612–2621; H. J. Webber and L. D. Batchelor: "The Citrus Industry," Vol I, Berkeley and Los Angeles, 1948, pp. 1–2.

On the role which the Jews played in spreading the citron to Mediterranean lands see S. Tolkowsky: "Hesperides—A History of the Culture and Use of Citrus Fruits," London, 1938, pp. 62–66 and 110–111.

Aspects of Jewish horticulture in the early centuries A.D. have been treated in numerous monographs which are relatively inaccessible to the current generation of geographers. The topic is most fully explored by I. Löw in his three volume work "Die Flora der Juden," Wien und Leipzig, 1924–1926. See also volumes of H. Grätz: "Geschichte der Juden," revised ed. 1900–1909; I. Schipper: "Anfänge des Kapitalismus bei den abendländischen Juden im frühen Mittelalter," Wien und Leipzig, 1907; G. Caro: "Die Juden in ihrer Wirtschaftlischen Betätigung im Mittelalter," Frankfurt, 1904, and, by the same author, "Sozial und Wirtschaftsgeschichte der Juden im Mittelalter und der Neuzeit," Leipzig, 1908, 1920.

of its distribution was, of course, limited by the requirements of the citron tree. A small evergreen with irregular branches, oval and slightly serrated leaves, the citron tree produces a fragrant yellow oblong fruit, from four to eight inches long, with a furrowed skin. Like other commercial citrus trees, it is unlikely to sustain damage if temperatures fall for short periods to 28° F., but is less able than other varieties of citrus to endure lower temperatures. The reason is that while in most citrus trees flowering takes place in early spring, the citron continues throughout the year to produce flowers in varying degrees of abundance. It is this absence of a period of dormancy which makes the tree more susceptible to frost damage. Growth is imperceptible above 95° F. While the water requirements of the tree are large, its cultivation can be carried out on a great variety of soils provided they have a favorable texture.[4] The citron does best on fine sandy loams although in some commercially producing areas plantings occur on what is almost pure sand.[5]

The citron is accepted by the Jews as the fruit commanded for use in the Feast of Booths. Leviticus 23:40 reads:

> And you shall take unto yourself on the first day the fruit of a goodly tree, palm branches, foliage of a leafy tree, and willows of the brook, and you shall rejoice before the Lord your God seven days.

The citron is not mentioned by name here nor anywhere else in the Bible. Documentary evidence for the acceptance of the citron as "the fruit of a goodly tree" is not present until the second century B.C. The presumption of its acceptance at a much earlier period rests upon Rabbinic insistence in the first centuries of the Christian era that the citron was the fruit originally designated and that it had always been accepted as such.[6]

[4] Webber and Batchelor, *op. cit.*, pp. 42–43, 55, 62.

[5] Burke, *op. cit.*, p. 113.

EARLY SPREAD OF CITRON

The citron, or *etrog* as it is known to the Jews, appeared in the Peloponnesus, one of the first centers of dense Jewish settlement outside Palestine, probably in the first century, and was certainly to be found there in the second century A.D.[7] In Mauretania, another area of early Jewish settlement, the citron was intensively cultivated at the beginning of the Christian era, and the tree appeared in Italy about the middle of the first century A.D.[8] While the citron occasionally appeared in non-Jewish art of the period, it was many times more frequent in Jewish art—so much so, in fact, that its presence in non-Jewish art is considered a sign of Judaizing influences.[9] While citrus cultivation died out in the centuries immediately following the fall of the Roman Empire and was not revived until the Arabs reintroduced it, the citron, despite great difficulties, continued to be grown because it fulfilled a religious obligation for a segment of the Mediterranean population.

Paradoxically, it was in the thirteenth and fourteenth centuries A.D., when the Jews had long since ceased to be numbered among the leading arboriculturists and horticulturists of Mediterranean Europe, that their influence on the distribution of centers of citron production became most marked. For a combination of reasons the Jews ceased

[6] For a discussion of the possibility of the early arrival of citron in the Middle East see Erich and Raël Isaac: "A Goodly Tree," *Commentary* (in press).

[7] S. Tolkowsky: "Hesperides—A History of the Culture and Use of Citrus Fruits," London, 1938, pp. 75, 77.

[8] *Ibid.*, pp. 69, 71–94.

[9] E. R. Goodenough: "Jewish Symbols in the Greco-Roman Period," Vol. 2, New York, 1953, p. 97.

to grow citron—partly because centers of Jewish population moved northward outside areas of possible citron production and partly because increasing legal restrictions were imposed upon Jewish landholding. It was precisely because Jews had to rely upon non-Jewish cultivation of citron that conflicts arose among the Jews concerning the conditions under which citron in given areas was produced. According to Rabbinic law, which derives its prohibition from a command in Leviticus 19:19 against sowing together diverse seeds, grafting is forbidden. In the case of the citron, grafting was considered peculiarly abhorrent since it meant that a forbidden object was used for a holy purpose.

THE ITALIAN SOURCE FOR CITRON

In the fourteenth century Italy was the source of citron for the Jews of Europe. So important had citron become that in 1329 victorious Guelph Florence prohibited the Republic of Pisa from engaging in the trade of citron and allocated to itself this lucrative export.[10] Travel grants were obtained by Jews in other lands to procure citron in Italy; in 1389, for example, Archduke Albrecht III of Austria issued passports to Jewish merchants for this purpose.[11]

By the middle of the sixteenth century the practice of grafting citron had become common in Italy. The rabbis took a firm stand against this development in emphasizing the prohibition against grafting. Noted Talmudic scholars and acknowledged authorities throughout European Jewry, such as Moses Alshech, prohibited the use of grafted etrogim, even though it might be impossible to distinguish grafted from ungrafted fruit on the basis of physical appearance.[12] Similarly Samuel Katzenellenbogen of Padua, in the sixteenth century, forbade the use of grafted citron.[13]

Within Italy itself there were, in the mid-sixteenth century, two major sources for etrogim. The region of Padua served primarily Jewish communities north of the Alps, while Apulia served Jewish communities in Italy itself, especially in times of scarcity in the crop from Padua.[14] The prevalence of grafting, the difficulty of distinguishing the grafted from the ungrafted fruit, and the lack of alternative sources induced a minority of rabbinic authorities to allow the use of grafted citron in cases where it proved impossible to obtain the true etrog.[15] Nonetheless the unreliability of etrogim, from Apulia especially, led to Jewish avoidance of this source and the eventual death of the citron industry there. Despite the presence of grafting, citron from northern Italy continued to be used up to the nineteenth century because Jews living in this region were able to detect the signs of the grafted fruit in their own area and avoided purchasing or exporting ritually unacceptable fruit.[16]

Italian etrogim were sent northward by two main routes: On the route regularly used by the Levant trade via Bolzano (Bozen) and Innsbruck to Germany, and from the head of the Adriatic Sea through the Pear Tree Pass to Ljubljana (Laibach) and from there to Maribor (Marburg) and on to Wiener Neustadt. Transport of etrogim was a

[10] Antonio Targioni-Tozzetti: "Cenni Storici sulla Introduzione di varie Piante nee'Agricoltura ed Orticoltura Toscana. Nuova ristampa per cura del Dott," Florence, 1899, pp. 157, 162.

[11] M. Wiener: "Regesten zur Geschichte der Juden in Deutschland," Hanover, 1862, p. 235.

[12] I. Löw: "Die Flora der Juden," Vol. 3, Wien und Leipzig, 1926, p. 292.

[13] *Ibid.*, p. 293.

[14] *Ibid.*, p. 293.

[15] As, for example, by Moshe Isserles (d. 1573) and M. Eisenstadt I (d. 1744). The ruling has been discussed and rejected by Daniel Terni in "Essence of the Law" (Hebrew), Florence, 1803, p. 99b.

[16] I. Löw, *op. cit.*, p. 293.

difficult matter because each fruit had to remain perfect in order to be ritually acceptable. The availability of markets along the route facilitated the trader's task.[17]

THE SHIFT TO NEW AREAS OF CITRON PRODUCTION

By the seventeenth century, trade with Apulia had ceased and new sources of supply had been tapped. Jewry north of the Alps and northeast of Dalmatia obtained citron from areas of production which may be divided into two groups: Catalonia and the Balearic Islands, especially Majorca; the coast and islands of the Ligurian and Tyrrhenian Seas, especially Corsica, Elba, and Sicily, and, on the mainland, the Riviera di Ponente and Riviera di Genoa, Campania, and Calabria. Genoa and San Remo acted as major points of assembly for the fruit from both these regional groupings and the fruit was then shipped north to the communities beyond the Alps. While the disrepute into which the citron of Apulia had fallen tended to cast doubt upon etrogim from southern Italy as a whole, proximity to the market explains in part the prolonged existence of citron groves as far north as Lago di Garda's Riviera di Salo, especially around Limone, where, despite climatic difficulty in maintaining orchards, the citron was grown extensively until the middle of the nineteenth century.[18] A third major grouping began to emerge as a source for citron, although it did not assume major proportions until the nineteenth century. This was in the east, from the Adriatic shores of the Ottoman Empire and from the Venetian-held Ionian Islands, especially Corfu, Cephalonia, and Zante. Venice channeled the trade from these areas.[19]

THE OTTOMAN MONOPOLY

The emergence of the Adriatic shores of the Ottoman Empire as a major source for etrogim at the turn of the nineteenth century came in part because trade in the fruit was a state monopoly of the Porte, which maintained strict control over the purity of the stock. Attention of the Jews had turned to the Ottoman Adriatic as a result of the difficulty which developed in obtaining citron from the second major regional grouping we have described. The citrons of Corsica and Elba especially, which were imported via Genoa, had long been held in the highest esteem, for here the fruit grew in wild and indisputably ungrafted profusion. The First Republic of France and the swift rise of Napoleon had the effect of hardening boundary lines between French and Austrian possessions, so that Jews in Austrian territories, including such major Jewish concentrations as Austrian Galicia and Poland, and the Jews in Russia and the Russian-held territories of Poland and Baltic Samogitia, Courland, and Livonia had to rely largely on Adriatic sources for their supply of etrogim. Trieste took the place of Genoa as the great entrepôt port for citron. Official supervision of the growing of citron in the coastal areas of Ottoman Albania and Epirus, especially in the orchards of Parga, Ayia, and several other villages of the provinces of Thesprotia and Preveza allowed the etrogim from this area to achieve as

[17] *Ibid.*, p. 296.

[18] S. Kluger and S. Minz in S. Minz, edit.: "Fruit of a Goodly Tree," (Hebrew) Lemberg, 1846, pp. 1, 9–11. There is an enormous amount of material of geographic interest in the various collections of rabbinic responsa. By and large rabbinic literature has been a closed book to the economic historian and geographer. In the following discussion this literature has been drawn upon by the author.

[19] Johannes Buxtorf: "Juden-Schuel . . . ," Basel, 1643, p. 483; Io. Bapt. Ferrarii (Senensis): "Hesperides sive De Malorum Aurorum Cultura et Uso Libri Quatuor," Book I, Rome, 1646, p. 39; I. Löw, *op. cit.*, p. 307.

high a reputation among the Jews as that formerly enjoyed by the citrons of Corsica.[20] The importance of the Ottoman Adriatic spelled the further decline of the Italian citron.

DECLINE OF THE "CORFU ETROG"

The seeds of the next shift came with the abandonment of the Sultan's monopoly of citron cultivation. By 1843 the growing and sale of citron was open to anyone interested in the fruit. The explanation for the state's giving up a monopoly which provided an excellent source of income may well have lain in the very fact of its lucrative character. Ottoman control over the Adriatic coast territories was never wholly successful, and, when the local population became aware of the profit to be derived from trade in citron, it is likely that in defiance of the state monopoly they began to grow and trade in the fruit themselves. Official abandonment of the citron monopoly was, in all probability, merely the acceptance of a long since accomplished fact.

For the Jews the significance of these developments lay in the growing impossibility of distinguishing between grafted and ungrafted fruit exported from this region. The Sultan's groves were concentrated in Parga, but to the Jews the fruit from all the orchards in the region was known as the "Corfu etrog," for Corfu channelled the trade from the Ottoman Adriatic to Trieste. With the end of the monopoly, all the fruit from the region, including now most of Albania, the Ionian Islands, and Corfu itself, was exported under the name, and accorded the local rabbinical certification of the "Corfu etrog."[21]

This situation gave rise to a great and heated controversy which did not end until the substantial abandonment of the region as a source for etrogim. European rabbis argued that local certification from Corfu was meaningless, since neither from superficial inspection nor on the basis of the botanical knowledge of the time could the grafted be distinguished from the ungrafted citron sent into Corfu and Trieste. The rabbis in both places were accused of self-interest in giving their certification indiscriminately under pressure from the local community which stood to gain from the trade.[22]

One after another the rabbis of important Jewish communities on the traditional trade routes from Trieste to northeastern Europe banned the Corfu etrog. From opposite ends of the Austrian Empire—from Brod, in Austrian Slavonia close to the border of Ottoman Bosnia, to Brody, at the time an Austro-Polish town near the Russian border—prohibitions were issued against the use of the Corfu etrog. These were duplicated by leading rabbis in Vienna, Cracow, Kishinev, and Jasi, as well as in other Jewish centers.[23] Unfortunately, while the majority of important rabbis of western as well as eastern Europe united to ban the Corfu etrog, rabbinic opinion was not unanimous,[24] nor, for that matter, were the masses of eastern European Jewry obedient to rabbinic authority. Hasidism had taken firm root primarily in Russia and Poland, and for these people the word of their own leaders had primary authority. Many of these Hasidic leaders, who, in the opinion of their flock, derived their authority from mystical intuition, maintained that the Corfu etrog was the divinely acceptable one.

[20] On the reputation of citron imported through Genoa see I. Löw, *op. cit.*, p. 294; S. Minz, *op. cit.*, pp. 12, 23b, 27.

[21] S. Minz, *op. cit.*, pp. 1-23b.

[22] *Ibid.*, p. 18b.

[23] *Ibid.*, pp. 1-34.

[24] B. Hacohen: "Decree of Permissibility," (Hebrew) Vilna, 1875.

However, while early rabbinic bans were only partially effective, the decline of the Corfu etrog was hastened by the sharp practices of the Corfiote merchants, who were anxious to profit further from an already profitable trade. Coming into contact with Hasidic Jews, these merchants formed an exaggerated view of the importance of the Corfu etrog to their Jewish market. They believed that Jewish superstition held that if a Corfu etrog was not used for the Feast of Booths, the man would die the same year. With his very life at stake, the merchants reasoned that the Jew would surely be willing to pay any price for the fruit.[25] Accordingly they resorted to the practice of dumping the fruit into the sea to force up the price, and etrogim became prohibitively expensive.[26]

In the 30-year period following 1846, when the first important series of bans against the Corfu etrog had been issued, more and more rabbis and with increasing effectiveness joined in the ban. In peaceful mid-nineteenth century Europe there were no longer difficulties in obtaining the Corsican citron, and this or the Palestinian, Moroccan, Campanian, Calabrian, and Portuguese citron were recommended by the rabbis.[27] These alternatives would probably have been accepted more readily if the Corfu etrog had not greatly surpassed the others in appearance. Even those rabbis who were most doubtful of its ritual acceptability conceded that the alternative fruits could not compare to it in beauty.[28] By 1875 we have indications that rabbinic bans, which may well have been aided by the rise in the cost of the Corfu etrog, had become highly effective, especially in those areas where Hasidism was not strong. In the Baltic provinces, for example, the Corfu etrog now found no market.[29]

But the virtual death blow to the citron industry channelled through Corfu came as a result of the wave of persecution suffered by the island's Jewish inhabitants. Under Napoleon, civil equality had been granted to the Jews, but, under English and subsequently under Greek rule, intermittent outbreaks against them occurred. These came to a head with the pogrom of 1891, which produced a violent reaction in Jews throughout the world. It became exceedingly difficult to obtain buyers for the Corfu etrog in Europe and, as far from the scene as the United States, where traders concentrated their efforts, pamphlets urged the American Jew to boycott the fruit. The importers were described as "traders in the blood of Israel," who "since there is hardly a man in Europe who will touch them bought these etrogim dripping with the blood of the children of Zion."[30]

RISE OF THE PALESTINIAN CITRON

Morocco, Tunisia, Corsica, and Calabria continued to be sources for etrogim and have remained so until the present day.[31] There has been one major addition—Palestine, now Israel, which has become the most important single producer in the Mediterranean.[32] The rise of the Palestine etrog coincided with the decline of that of Corfu. Etrogim were, of course, grown from ancient times in Palestine and individual citron reached European Jewish dignitaries,

[25] I. Löw, *op. cit.*, p. 299.
[26] M. Rom: "A Call to Account" (Hebrew), Mainz, 1876, p. 4.
[27] *Ibid.*, p. 6.
[28] J. Minz: *op. cit.*, p. 32.
[29] M. Rom, *op. cit.*, p. 56; see also J. Partsch: "Die Insel Korfu. Eine Geographishe Monographie," *Petermanns Mitteilungen*, Ergänzungsheft No. 88, 1887, p. 91.
[30] E. Deinard: "God's War with Amalek," (Hebrew) Newark, 1892, p. 5.
[31] G. F. Callaghan, Plant Quarantine Division, U. S. Dept. of Agric., personal communication, January 23, 1958.
[32] H. Oppenheimer: "Etrog," (Hebrew) *Encyclopaedia Hebraica*, Jerusalem, 1954, p. 491.

but there was no significant trade until the latter part of the nineteenth century.

The chief impediment to widespread acceptance of the Palestinian etrog in Europe was the prevalence of grafting there as in Europe. A number of citron groves had been established in the coastal plain near Jaffa by foreign non-Jewish investors who grew the fruit for its commercial uses. Citron oil is an ingredient in some perfumes and the citron was also considered to possess medicinal properties. Sefardim, largely Jews of Spanish and North African descent, who held no deep convictions on the subject of grafting, in 1875 began to take advantage of the presence of these orchards to send citron to Europe for use in the Feast of Booths. Such practices, which were discovered by European Jews, almost killed Palestinian etrog exports in their inception.

The industry was saved by the presence in the interior around Um el Fahm on the southern slopes of Wadi Arah (Nahal Eron—ca. 10 miles southwest of Afula) and at Lifta, about 2.5 miles northwest of Jerusalem, and at Alma ca. 6 miles north of Safad[33] of wild untended groves held in high regard by the orthodox Jewish community of Jerusalem. Certain Jerusalem merchants undertook to make the Um el Fahm etrog a commercial product by transforming the wild groves into carefully cultivated orchards. They also undertook a publicity campaign to familiarize European Jews with these etrogim and to distinguish them in the public mind from the grafted etrogim of Jaffa exported by the Sefardim. In the process they established to the satisfaction of the majority of Jews the ritual acceptability of most untended citron groves, such as those of Lifta and Alma, outside the coastal plain of Palestine.[34] To the Jews of Palestine, who were attempting to build up a Jewish agriculture, the development of the citron industry was of inestimable value because the fruit had a guaranteed overseas market. Further, the citron provided experience in the cultivation and export of one type of citrus product, an experience to prove of value in the subsequent development of large scale production of other types of citrus fruits. While Israel is the main producer of etrogim today, the citron nonetheless constitutes a minor percentage of the state's total citrus output.[35]

[33] B. Salant and L. Sondal: "Pamphlet Concerning the Etrog" (Hebrew), Jerusalem, 1877, pp. 3–4.

THE RELIGIOUS IMPACT

We have shown that the present day location of citron groves in the Mediterranean; in Italy in the Calabrian province of Cosenza, and in the Campania of Salerno and Potenza; in Greek Epirus; in Corsica; and in North Africa[36] has been influenced to a large degree by religious considerations. The historic shifts in the location of the industry, from Apulia to Calabria, from Corsica to Parga, Corfu, and the Ionian Islands, and then back to the western Mediterranean, mainly the Tyrrhenian islands and coasts, and finally the addition of Palestine were not primarily economically induced. Economic forces tend to bring an horticultural industry as close as possible to its markets, but as Jewish centers were concentrated ever more to the north and east of the Mediterranean,

[34] *Ibid.*, pp. 18–19. A newly organized citron grower's association publicized the Palestinian etrog in "Galed," published in Jaffa in 1909 as well as in A. Y. Hacohen Kuk: "Kol Behadar" Jaffa, and S. Marcus: "Book of the Etrog" (Hebrew), Cracow, 1900.

[35] Before World War II an average of 60,000 units were exported annually from Palestine. Due to the annihilation of European Jewry exports have been reduced since the war and fluctuated between 25,000 to 30,000 units annually. H. Oppenheimer, *op. cit.*, p. 491; *Israel Weekly Digest*, October 9, 1957.

[36] H. J. Webber, *op. cit.*, p. 631.

growing areas of citron shifted most inconveniently in relation to established trade routes.

The fact that religion has played a considerable role in the location of present day citron groves does not mean that citron today depends upon a Jewish market. With the virtual destruction of the Jewish communities of Europe during World War II, Europe ceased to be a significant market for etrogim. The Feast of Booths, moreover, has ceased to be an important holiday for the great majority of Jews. Its ritual celebration is confined to observant Jews, who are a small minority in Israel as well as in the Jewish Diaspora. Paradoxically, it is for this reason that religious influences continue to shape the location of citron groves within the state of Israel. In a society where there is prevailing indifference to traditional orthodox standards, and indeed often open hostility to them, the orthodox Jew has grown to prefer citron produced in villages or cooperative villages where an orthodox population is concentrated or where it is a substantial landowning minority, as at Petah Tiqva, Rehovot, Hadera, Ness Ziona, and Kfar Haroeh.[37] Thus present citron groves in Israel are almost exclusively in those orthodox-enclaves where citron growing is climatically possible.

Although citron production outside Israel is no longer primarily directed to a Jewish market, this market is still a factor in as much as there are minority groups within orthodox Jewry, even in Israel, which prefer, on traditional grounds, citron from Calabria, Corfu, Morocco, and Tunisia. Corsican production, in particular, has experienced a marked increase since World War II.

At the present time the greater part of citron production is used for candied citron peel. Since grafted trees tend to produce better fruit with greater immunity to plant diseases, grafting is almost universal. The growth of the citron industry in the western hemisphere, as, for example, in the Caribbean and in Latin America, owes nothing to religious influences. But though the religious need of the Jews, historically so decisive, has since World War II played a minor role in the citron industry as a whole, this need will continue to have some influence upon the future of the Mediterranean citron. Ungrafted groves, in particular, will owe their persistence to the Jewish market.

[37] H. Oppenheimer, *op. cit.*, p. 491; *Israel Digest*, Oct. 9, 1957.

MICROGEOGRAPHIC SAMPLING

A QUANTITATIVE APPROACH TO REGIONAL AGRICULTURAL GEOGRAPHY

J. M. Blaut

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THE possibility of using formal statistical sampling in geographic research has recently received a certain amount of attention, but no statement of the degree or limits of usefulness of the procedure has appeared.[1] It would seem that our task at this stage is to demonstrate specific areas of geography in which the sampling approach may be fruitfully employed.

[1] See discussions in P. E. James and C. F. Jones, Edits., *American Geography: Inventory and Prospect*, Syracuse University, 1954: "One [frontier of regional study] has to do with the procedure for the selection of sample studies. . . . Students of statistics have devised sampling procedures with a high degree of reliability; students of regions are challenged to propose procedures for sampling areal rather than numerical groupings" (Derwent Whittlesey, p. 62). "The question remains whether better results can be obtained [from sampling in agricultural geography] by making use of geometric or statistical methods for selecting samples, or by depending on the trained judgment of the field investigator" (Harold H. McCarty, *et al.*, p. 269). For a concrete illustration of the usefulness of statistical sampling in land-use surveys, cf. Walter F. Wood, "Use of Stratified Random Samples in a Land Use Study," *Annals Assn. of Amer. Geogrs.*, Vol. 45, 1955, pp. 350–367. Wood's paper deals primarily with estimates of area from sample-based data. The application of sampling to geomorphology, with stress on techniques of statistical manipulation, is discussed by Arthur N. Strahler in "Statistical Analysis in Geomorphic Research," *Journal of Geology*, Vol. 62, 1954, pp. 1–25. Discussions of applicable sampling methods will be found in J. M. Blaut: "Micro-Regional Sample Surveys in Applied Agricultural Geography: A Preliminary Statement," *Proceedings of the Louisiana Academy of Sciences*, Vol. 17, 1954, pp. 100–106.

The present paper deals with one phase of the subject: the application of representative probability sampling, in combination with microgeography, to a problem in applied regional geography which as yet seems not to have been solved by any other means. While the method—termed for convenience the "micro-regional sample survey"—is discussed here in relation to a specific type of problem, it is clearly adaptable to somewhat wider use. It may, in fact, illustrate the basic approach needed to quantify regional geography and generalize microgeography.

Regional Geography and Agricultural Development

Attempts to incorporate regional geography in basic research programs preceding agricultural development, especially in underdeveloped areas, have encountered serious obstacles. These have arisen primarily from the discrepancy between geographic field methods and the ordinary focus of regional geography, and have resulted in a failure to provide the kind of precise and intensive data needed as a prerequisite to development.

In applied research the essential aim is prediction, and the test of adequacy is simply whether action taken on the basis of our conclusions will succeed or fail. We should, therefore, be able to supply information having high predictive value

in determining the probable effects and aftereffects of alternative policies. This requirement establishes threshold criteria of accuracy and breadth: accuracy must be sufficient to allow precise determination of norms and variations, and breadth should be sufficient to include all relevant factors. The latter will follow logically from the regional approach, but the former can only come with a scheme of research combining *intensity of treatment* with *representativeness of coverage.*

The field methods of geography are sufficiently detailed to satisfy these criteria. Geography has evolved as a field science, seeking to build its regional descriptions and interpretations on a solid foundation of particular knowledge, much of which derives from field investigation of individual phenomena and their local areal associations. In line with this approach a set of careful field techniques has been worked out for analysis on a level essentially coextensive with the visual horizon of the field investigator. While the goal may be macro-regional synthesis, the means preferred are microscopically intensive—in a real sense microgeographic. Incorporating techniques borrowed from such neighboring disciplines as pedology, farm management, and ethnography with our own, we should currently be in a position to obtain the required data at any specified level of intensity.[2]

Clearly, perhaps inevitably, regional geography has not made optimal use of these available methods. To obtain an immense volume of field data, adequate for full understanding and prediction in the absence of reliable secondary data, would be prohibitively difficult under normal circumstances for any moderately large area. Yet just such areas provide the usual scope for provincial, national, or "regional" agricultural development programs. Furthermore, while reliable secondary sources would reduce the need for field work, the pre-existing data available in underdeveloped areas are inadequate, outdated, or even absent entirely, and dependence on primary-data collection is correspondingly greater if usable results are to be achieved.

Thus the problem becomes one of discovering some means of adapting the field approach to moderately large areas, of obtaining the intensity and detail of microgeography for a macro-region as a whole. Regional geography, by virtue of its breadth of scope and precise field techniques, should qualify for a central role in agricultural development research in underdeveloped areas—more so than any specialized discipline. So far it has largely failed to participate in such work, except by contributing systematic surveys on limited phases and by integrating the data supplied by other sciences. This would seem to result from the lack of a practical solution, under normal conditions of limited time and resources, to the problem of macro-regional intensity and detail.

MICRO-REGIONAL SAMPLING UNITS

The essential thesis maintained in this paper is that such a solution can be found in a field approach combining microgeographic techniques with formal, i.e., statistically representative, sample design. This involves (1) determining the classes of data needed in a given problem; (2) organizing research procedures, to the greatest extent possible, around the study of micro-regions as field-work units; (3) replicating the micro-regional studies over a small but statistically representative fraction of

[2] See J. M. Blaut: "The Economic Geography of a One-Acre Farm in Singapore: A Study in Applied Microgeography," *Malayan Journal of Tropical Geography,* Vol. 1, 1953, pp. 37–48.

the macro-region (the "universe"); and (4) supplementing the microgeographic field work with other procedures, such as macro-regional data-collection (marketing routes, climate, etc.), historical analysis, and detailed qualitative study of selected micro-regions.

Microgeographic theory and methods have been dealt with fully by Platt in several pioneering studies.[3] His approach, and that of the present paper, are essentially regional, and might be termed "micro-regional geography" to distinguish them from the large-scale systematic studies of selected features. For our purposes the central concept in the approach is that of the *micro-region*, which may be either a basic, "building-block" unit of area, or an arbitrarily-defined unit of convenient size. In agricultural areas the farm (however defined) is obviously a valid micro-region, viewed from either standpoint.[4] It represents a fundamental unit of resource utilization and organization, material culture, demography, and social organization, and it is a logical starting place for gathering most types of relevant data. The farm, then, is a basic unit of study, and usually of sampling, in the type of work discussed here.

The particular field methods needed for intensive geographic treatment of the individual farm are well known. W. D. Jones, Sauer, Finch, Kniffen, C. M. Davis, and many others have fully explored the methodology of intensive, local study of particular element-complexes, while Platt has dealt with the fusion of these complexes into micro-regions.[5] However, the problem of assembling micro-studies into a full macro-regional structure appears not to have been dealt with adequately as yet.[6] Ideally, of course, we should seek complete areal coverage by contiguous micro-studies, but rarely would this be possible. It appears, then, that some kind of selection is called for.

CASE STUDIES AND SAMPLE SURVEYS

The same problem, in various forms, is confronted by most social scientists. They find it necessary to derive accurate generalizations about large, heterogeneous populations, yet lack the resources for complete enumeration—corresponding in geography to complete areal coverage. Social psychology, sociology, political science, economics, and agricultural economics have long dealt with this type of problem, and a branch of the last-named, the discipline known as farm management, has had the most experience with, and greatest success in solving, the problem among those fields concerned with rural areas. For this reason, and also because the viewpoint of farm management closely approaches that of agricultural geography, it may be well to consider the methods used in farm

[3] See, in particular, Robert S. Platt: "Items in the Regional Geography of Panama: with Some Comments on Some Comments on Contemporary Geographic Method," *Annals Assn. of Amer. Geogrs.*, Vol. 28, 1938, pp. 13–36; "Reconnaissance in British Guiana, With Comments on Microgeography," *ibid.*, Vol. 29, 1939, pp. 105–126.

[4] There are, of course, exceptions, where complex tenure and management relations obscure the fundamental land unit.

[5] For example, the following: W. D. Jones and C. O. Sauer: "Outline for Field Work in Geography," *Bull. of Amer. Geogr. Soc.*, Vol. 47, 1915, pp. 520–525; W. D. Jones and V. C. Finch: "Detailed Field Mapping in the Study of the Economic Geography of an Agricultural Area," *Annals. Assn. Amer. Geogrs.*, Vol. 15, 1925, pp. 148–157; V. C. Finch: *Montfort: A Study of Landscape Types in Southwestern Wisconsin*, Geographical Society of Chicago, Bulletin 9, 1933; F. B. Kniffen: "Louisiana House Types," *Annals. Assn. Amer. Geogrs.*, Vol. 26, 1936, pp. 179–193; H. F. Gregor: "A Sample Study of the California Ranch," *ibid.*, Vol. 41 (1951), pp. 285–306; C. M. Davis: "Field Techniques," in *American Geography: Inventory and Prospects*, Syracuse, 1954, pp. 496–529; and R. S. Platt, *op. cit.*

[6] "There is little or no correlation between the intensive studies of small areas and the more general studies."—Harold H. McCarty, in *American Geography, op. cit.*, p. 268.

management for the selection and replication of unit studies.

During the latter part of the last century, agricultural economists began to perceive the need for careful study of the individual farm's financial structure, in connection with efforts to establish a research base for local extension. Several lines of effort were initiated, and two which proved highly successful became known as the *case study method* and the *survey method*, respectively. Both are essentially comprehensive economic studies of individual farms, although partial studies of particular enterprises are also included. (It might be noted that farm management, concerned almost exclusively with the individual farm as a basic unit in rural economy, bears the same relation to agricultural economics as a whole that microgeography [or micro-regional geography] does to geography.)

The case study method involves detailed investigation of a small number of farms, usually an unrepresentative group. The survey method, on the other hand, sacrifices a certain amount of detail for statistical adequacy: here a probability sample is selected, by orthodox methods, and each farm in the sample is studied. If the sample is truly representative, and field methods are sufficiently precise, norms and variations determined for the sample can be generalized to the statistical "universe," the farming area as a whole. The sampling fraction, variability of the area, and various other calculable factors will specify within fairly precise limits the accuracy of generalizations from the sample data. Since, however, the sample survey requires a large number of individual studies, the amount of attention which can be devoted to each is necessarily limited.

The case study method, by contrast, distributes available field time over a much smaller number of farms and allows far greater intensity for each, achieved often through repeated and prolonged visits to those selected. By studying in detail all factors bearing on farm management, and their modes of interaction, it achieves careful understanding of both static characteristics and relationships, structure and function. Many of the features will be somewhat constant throughout a given region, and a degree of generality will thus be achieved; lack of representativeness, conditioned by the limits on time and resources which normally preclude the taking of a fair sample at the case-study level of intensity, make it impossible to judge the actual degree of representativeness of the data, however. By combining both methods in the study of an area, superimposing the one on the other, maximum intensity and maximum generality—micro-regional detail and macro-regional representativeness—can be achieved.[7]

The manner in which farm management has gone about solving the problem of obtaining predictive accuracy without loss of areal scope suggests certain conclusions for geography. Most past efforts in the latter field have been roughly of the case study variety; they have involved the selection of one or at best a few units in a given macro-region, often dealing quite intensively with each unit chosen. By providing the sort of data which are fairly constant, or at least moderately typical, in a cultural or natural region, and determining the characteristics and interrelations of the features studied, they have proven of considerable value. But such micro-regional case studies do not allow

[7] These methods, under the same or different names, are used in most behavioral sciences. For a definitive discussion of their use in farm management see J. Norman Efferson, *Principles of Farm Management*, New York, 1953, especially pp. 4–5, 10–12, and 47–67.

generalization for any quantitative variable, and where, as is usually the case, the macro-region is internally diversified, they do not even allow precise generalization for qualitative attributes. At best they dissect, without defining, a norm, and provide little basis for judging intra-regional variation. Further, since their primary purpose usually has been qualitative illustration of regional characteristics as they appear at the microgeographic level, they have tended to underemphasize quantitative variables which would be of significance in planning—income, cultivated acreage, yields, etc. It thus appears that a moderate dilution of over-all intensity, with, however, some increase for relevant quantitative features, is desirable for obtaining a type of micro-study suitable to replication on a representative basis.

While we may argue over the degree of representativeness of subjectively-chosen micro-studies, *true* representativeness—of the sort which permits us to state regional norms and variations with confidence and specificity, and also our probable limits of error—can only come with formal probability sampling, or with total-area coverage. Since the latter is prohibitively difficult in most cases, it is suggested here that an adaptation to our own purposes of the survey method, accompanied by statistically-valid sampling, can best reduce the problem to manageable proportions.

REGIONAL SAMPLING

The choice of a sampling method for any given micro-regional survey will depend on the characteristics of the locality and the type and circumstances of the project. Of the several methods available, each has merits for certain classes of situations and can be fully evaluated only when we have a mass of comparative data from geographic application. Usually the selection of a method for a particular investigation will depend largely on relative cost in relation to the goals of the work, although some methods will often be ruled out as impracticable. A few words on three well-known sampling methods will suffice to illustrate the approach.[8]

The *simple random sample* is obtained by selecting, purely at random, a certain proportion of the farms in a region under study. The farms may be drawn from a list in advance, or may be selected in the field according to some randomizing procedure. Probably the simplest way of using this sampling method is to compile a list of farms, obtaining the list from some reliable and up-to-date source, or by examination of air photos (in areas where photos are available and individual farmsteads or farm houses can be positively identified on them), or, if necessary, by going into the field and counting; then give each farm a number; and, finally, select the farms to be included in the sample by drawing numbers out of a hat or by referring to a table of random numbers.

The *stratified random sample* is obtained by breaking down the statistical universe—in this case the total set of farms—according to one or more characteristics relevant to the problem, and selecting a random sample from each of the classes or strata. As a result of the breakdown, each of these strata exhibits less variability than the universe as a whole, and lower variability tends to

[8] For general discussions of sampling, including area sampling, see: Margaret Parten: *Surveys, Polls and Samples*, New York, 1950; and M. H. Hansen, W. N. Hurwitz, and W. G. Madow: *Sample Survey Methods and Theory*, 2 vols., New York, 1953. Strahler's "Statistical Analysis in Geomorphic Research" (*ob. cit.*) provides an excellent discussion of statistical manipulations with sample-based data. See also a discussion of the analysis of variance with sample-based data in "Design of Experiments for Statistical Analysis of Geological Data," W. C. Krumbein and R. L. Miller, *Journ. of Geol.*, Vol. 61, 1953, pp. 510–532.

allow a smaller over-all sample, or higher accuracy with the same size of sample. A relatively homogeneous population requires a smaller total sample to provide the same level of accuracy, and the division of a population into, say, four parts on the basis of one relevant characteristic will reduce considerably the variability in each stratum associated with that characteristic. Thus the stratified random sample is preferable to the simple random sample, but requires more advance information about the farms: whereas the simple random sample can be drawn if we have a list of identified farms, the stratified sample requires not only this information but also data on a characteristic of the farms which relates to the problem under consideration. Fortunately, if the areal spread is large enough, variations in relief, climate, or major crop can frequently be used for stratification —but only where we know in advance that such features are related to a given problem.

In order to illustrate the problems an investigator may face in trying to obtain a stratified random sample, we may mention an unsuccessful attempt along these lines made by the writer and others in the course of a field study in Jamaica in 1957. The aims of the investigation were to discover the cultural determinants of soil erosion in a badly-eroded portion of the Blue Mountains, and to find a means of altering these factors in order to pave the way for a soil conservation program.[9] The principal procedures employed in this study were interviewing—to discover social and economic attitudes, costs and returns, knowledge of erosion processes and conservation measures, etc.—soil mapping and analysis, observation of farming behavior, and farm mapping. The problem was thus microgeographic in scale and required intensive treatment of each farm. To obtain data which could be generalized to a macroregion (even a small one), it was necessary to employ probability sampling.

Unfortunately, the field team had little prior knowledge concerning the farms in the area and, more important, could not predict with certainty that any of the known characteristics of the farms (approximate acreage, size of family, and a few other items) related directly to erosion-inducing behavior. Thus stratification would have required either (1) an enumeration of those farms practicing soil conservation, or (2) an index of the degree of erosion present on each farm. To obtain either of these classes of data the team would have had, at the very least, to ask each farmer the boundaries of his farm (usually fragmented into two or more portions), and then observe and map the farm. This would have had to be done at the start of the investigations, before rapport had been established. Questions and behavior of this sort would have branded the team indelibly, in the eyes of the farmers, as agents of the government and therefore suspect, and would have destroyed the much-needed rapport at the start. The goal of obtaining a stratified random sample was, therefore, regretfully abandoned.

This left, as the best alternative, simple random sampling, which was the method finally selected. Farms were located on air photos and numbered; numbers were drawn out of a kettle; and each selected farm was visited. Seventeen out of a total of 51 farms—a one-in-three sample—were studied, and a second sample of seven

[9] The study, as yet unpublished, was sponsored by the Conservation Foundation and the Research and Training Program for the Study of Man in the Tropics (Columbia University). Participants included the writer as director, two anthropologists (Ruth P. Blaut and Michael H. Moerman), and a conservationist (Nan Harman).

was drawn for detailed, largely qualitative, analysis.

Even a simple random sample will be unobtainable if circumstances are such that a list of farms cannot be procured beforehand and field selection of farms is impracticable. This problem will arise frequently in underdeveloped areas: official, church, or other agencies which are usually the sources of farm lists may not have them, or the information may be out-dated; and field selection of a simple random sample may be impossible where air photos are either not available or not usable for this purpose. In such cases a third sampling method, *cluster* or *block sampling*, will often prove useful.

The randomized or stratified-random block or cluster sample is a method of sampling area-units rather than farms. In one of its simpler forms it involves dividing a region into a set of equal-sized areal units and sampling these units, each of which includes several farms in most cases, by randomizing procedures. A grid laid over an ordinary topographic map will often suffice for selecting the units. Another form of cluster sampling involves plotting sample points, usually from grid intersections, and selecting a certain area or a certain number of farms around each point.

This sampling method has the incidental, but very useful, advantage of clustering field studies into a relatively small number of localities. However, it suffers from some rather serious limitations, one being the much larger number of farms which will usually be required to attain a given predictive level.[10] and another being the difficulty of locating oneself (or one's assistants) in the field precisely at a given plotted sample point or along the edge of a given sampled grid square. The first limitation can be overcome somewhat if the areal units can be stratified; the second, if time for checking or surveying field locations is available.

A hypothetical example may be added, in order to demonstrate the theoretical efficiency of the sampling approach. The example deals with a pre-development geographic field study, more or less "regional" in breadth. If it has been determined that a 3 per cent sample will suffice for representativeness and precision in a particular area containing 10,000 farms, 300 micro-studies will be needed. If one field worker can obtain two studies in a day—the writer's experience suggests that this may be a reasonably secure minimum where high intensity is not required and where field time equals or exceeds travel time—the total number of man-days required for the project will be about 150. Although the number of farms in a region under study will normally be much greater than 10,000 where a development program is involved, it may be assumed that available field time and number of workers will be correspondingly greater.

Two supposed shortcomings of the sampling approach in geography should be considered at this point. The notion that sample data must be numerical—intra-unit variables, such as yields, area, income, size of family, proportional importance of each crop, labor time, etc.—is quite incorrect. Qualitative attributes of the unit are equally accessible. Farming type, cultural affinities, language, dominant product, soil type, material-culture complex, and, in fact, any relevant presence-or-absence identification can be determined for each unit. The fact that such features are qualitative does not mean that we can ignore questions concerning their quantitative significance in an area: for our purposes it is not sufficient to say

[10] Cf., Parten, *op. cit.*, p. 118.

that a given farming type "dominates," or is of "secondary importance" in an area; we must be able to state with confidence the specific proportion of farms falling within the type, since development programs will differ according to type and the allocation of resources for development will depend on this information.

The second objection asserts that accurate maps cannot be prepared from sample-based data. This ignores the existence of a vast number of such maps, dealing especially with climate, demography, and agriculture. Valid statistics concerning each sample point provide a standard for judging the accuracy of interpolated isopleths, as Blumenstock[11] has pointed out in connection with meteorological data, and statistically-firm sample data permit the portrayal of some distributional features with greater confidence and precision than generalized, often superficial and subjective, total-area data. For any macro-region containing a large number of farms the probability is high that sample units will be distributed evenly enough to allow the drawing of isopleths; it will be even higher if stratification is employed. Block sampling, on the other hand, will leave large areas untouched, and some supplementary field work will be necessary for medium- or large-scale maps. Thus, while there are limits to the amount of mapping that can be incorporated in a sample survey, these normally should not pose a serious problem. And, as will be shown later, the amount of detailed region-wide mapping necessary in a survey of this sort should be rather small. The need for maps will be governed rather by the purposes of the research than by the geographer's innate predisposition toward mapping, and thus the project will emphasize highly detailed farm (or village) maps—necessary elements in the survey in any case, since areas will have to be measured in the field—and small-scale, generalized, macro-regional maps showing major subregions, lines of communication, markets, etc., which do not require detailed, total-area field work.

[11] David I. Blumenstock, "The Reliability Factor in the Drawing of Isarithms," *Annals. Assn. of Amer. Geogrs.*, Vol. 43, 1953, pp. 289–304.

Levels of Intensity

The foregoing discussion has assumed what may be called a single-level approach, with one level of intensity applied to all farms. It will often prove desirable to extend the research to other levels; to seek, on the one hand, further intensification through the use of case studies and, on the other, broader areal coverage combined with lower intensity, by means of selective systematic surveys.

Some farms, of course, will have to be visited more than once, for completion, verification, and correction. However, some classes of data will need further amplification and others will have been left out of the survey entirely for lack of time. Here the case study can be of use, as it was in the Jamaica investigation described earlier. Some features are relatively constant throughout large parts of a natural or cultural region, but at the same time are too complex or obscure for treatment in the initial sample survey. Others, also inaccessible to the sample survey, are significant by virtue of their qualitative characteristics, regardless of quantitative variability. In both instances the highly detailed study of a few selected farms whose representativeness is not known, or cannot be verified statistically, will often prove of considerable value. In some cases it may even be possible to draw these farms as a subsample from the original sample. Bases

for complex stratification will have been obtained in the initial survey, and the most serious problem in drawing the sub-sample will be that of judging whether the fairly large number of cases required for the sub-sample is justified in relation to the data to be obtained and the cost of obtaining them. If, however, case studies are fitted to a sub-sample, their value will be considerably enhanced: it will be possible to determine the generality of these highly detailed data for the area as a whole. Even greater detail can be obtained from correlations between paired classes of data in the sub-sample where one of the pair is known for the original sample, using a nomograph.

Conversely, higher regional generality on a level which can only be achieved through complete areal coverage may be desired for certain kinds of data. This might hold true for soils information, although the sample survey, by investigating soils, would probably serve in place of a reconnaissance soil survey —and a full soil survey usually follows, rather than precedes, the initial stages of planning in underdeveloped areas. A total-area land-utilization survey might also be useful if the sampling method chosen left large areas uncovered. Under certain circumstances, however, the sample survey combined with a topographic map would allow compilation of a land-utilization map sufficiently detailed for planning purposes. Where up-to-date, large-scale, air photos are available the field work can be used in the preparation of a key, and ground surveys will be unnecessary. In any case, the need for a land-utilization survey to provide data other than those necessary for a map would be eliminated by a sample survey.[12] Data associated with a macro-region as a whole, rather than with the individual farms—climate, relief, over-all settlement patterns, integrating mechanisms such as marketing lines and urban foci, etc.—will, of course, require total-area surveys. But these need only be rapid, inexpensive surveys.

[12] Wood, *op. cit.*, p. 367.

CONTRIBUTIONS TO AGRICULTURAL DEVELOPMENT

The chief value of the method of micro-regional sample surveys results from its procedural simplicity, as the easiest means—in most underdeveloped areas the only means—of obtaining primary regional data which are sufficiently precise and detailed to serve as a basis for local agricultural development programs. If such programs are to be more than restricted, unilateral, projects, the research on which they are based must encompass an extraordinary range of phenomena, too broad for any one science except geography. By virtue of his viewpoint and techniques, the regional geographer is in the best position to describe the characteristics and areal patterns of these phenomena, and, equally important, to examine their functional inter-relations. By extension, the task of venturing sound predictions and fashioning realistic planning models is properly his, also. And, since the critical primary data are, for the most part, found at the level of the individual farm or rural village, the special techniques of microgeographic field investigation, which he has evolved for work at this level, provide a means of achieving suitable intensity of detail.

But one further element is needed, a methodological tool which will permit the regional geographer to generalize his data to a macro-regional planning unit without loss of the required breadth, intensity, or quantitative reliability. The tool most widely used in other sciences faced with this type of problem

is sampling, by which is meant the selection of representative fractions by statistically-valid procedures, and the argument presented here suggests that this tool is accessible to the regional geographer in his microgeographic investigations of farming.

In pre-development research of this sort the regional geographer will serve three functions, each a distinctive geographic contribution, and each provided with the credentials of dependability which sampling affords. First of all, by virtue of his special viewpoint and methods, he will assume responsibility for the investigation of the resource-utilization complex, seen as a set of related physical and behavioral processes—clearly as unique and unitary a body of subject matter as is possessed by any science. Secondly, he will examine the distributional patterns and areal differentiation of all relevant classes of phenomena. And, finally, on the theme of the present paper, he will employ the breadth of perspective of regional geography to secure basic, minimal, information on essentially all of these classes of phenomena. Ethnologists, agricultural economists, engineers, and planners can proceed from there.

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The writer wishes to acknowledge his indebtedness to the following who stimulated many of the ideas on which this article is based: Professors Fred B. Kniffen and J. N. Efferson, Louisiana State University; Professor Robert S. Platt, University of Chicago; and Dr. Peter You Poh Seng, University of Malaya.

NOTE: Attention is called to a correction in "A Note on Central Place Theory and the Range of a Good" by Brian J. L. Berry and William L. Garrison which appeared in the October, 1958, issue of this magazine. Professor Charles M. Tiebout has pointed out to the authors that Footnote 15 should read as follows:

> Assuming monopolistic competition, with no excess profits for the marginal firm (in this case frozen food lockers). The marginal firm, after equating marginal revenue and marginal cost, finds that it makes only normal profits. That is, average cost just equals average revenue. See E. H. Chamberlin: *The Theory of Monopolistic Competition*, Cambridge, 1947.

BOOK REVIEWS

The Federal Lands: Their Use and Management, by MARION CLAWSON and BURNELL HELD. xxi and 501 pp.; ills., index. Published for Resources for the Future, Inc., by The Johns Hopkins Press, Baltimore, 1957. $8.50. 9 x 6 inches.

Messrs. Clawson and Held have made three major contributions to an understanding of *The Federal Lands*. First, they have produced a useful reference source of statistics relating to the public lands. A statistical appendix of 59 tables utilizing 72 pages gives a handy summary of the quantitative facts concerning ownership, use, revenues, expenditures, leases, royalties, and similar data with respect to the nationally owned lands. Anyone who has looked for or tried to compile statistics relating to these matters will realize the extraordinary usefulness of the compilation. One gathers from the foreword that the statistical job is largely the work of Held. All students of public land matters owe him a vote of thanks. In addition to bringing the statistical time series up through 1956 many of the tables include (where appropriate) projections of the same series to 1960 and 1980. The projected values, some made by the authors, others by the several public land management agencies, are arrived at generally by simple extrapolation of recent trends. The projections may very well prove inaccurate, but it is unlikely that they will turn out to be more than a fifth or a fourth off the mark. If the authors' projections of cash receipts from Public Domain lands (Appendix Table 14, p. 421) prove to be overestimated by a fourth, cash receipts in 1960 will, nevertheless, total nearly three times what they were as recently as 1956. If they have underestimated by 25 per cent, the 1960 receipts will be nearly five times the 1956 receipts. In almost every case a tremendous increase in use of the various resources of the public domain seems imminent.

Adequately to cope with the nearly certain great increases in demand for and use of public land resources will necessitate extensive modifications of the organization, administration, budgetary practices, and legal authorizations of the administering agencies. What these changes should be is problematical, and it is toward a solution of that problem or group of problems that the body of the volume is directed.

The second major contribution of the book consists of a review of the history of federal land management and administration based on the assumption "that the lessons of the past have relevance for the future" (p. 334). The authors open the discussion with a chapter on "Federal Lands in American Society, Past and Present," wherein they divide our federal land history into five chronological though overlapping periods—period of acquisition, era of disposal, era of reservation, era of custodial management, and era of intensive management. Clawson and Held believe that we are currently making a transition from custodial to intensive management; the changeover, they suggest, has been particularly rapid since the end of World War II. This transition they anticipate will proceed at an increasing rate. Consequently, in the succeeding chapters, they review briefly the entire history of administration of the various federal land resources, but they have chosen to concentrate most of their attention on the recent past and the current situation. They have organized their materials into four long chapters (of 60 to 80 pages each) under the titles: uses of the federal lands; policy formation and decision making; pricing processes and investments on federal land; and revenues and expenditures. Together these chapters constitute not only an interesting and instructive summary of current public land use and management, but they also serve as an excellent reference volume on current federal land use conditions and practices.

The book ends with a 123-page chapter addressed to the question, "What of the Future?" It presents the views of Clawson on the question of a future governmental setup adequate to cope with the problems which the rapidly increasing intensity of use of the federal land resources will engender. It is the third major contribution of the book.

Of the numerous possible administrative arrangements which the authors discuss they clearly have one favored arrangement. However, their analysis of the various proposed solutions is so impartial, dispassionate, and penetrating that in itself it is wonderfully instructive. To this reviewer the analysis and the discussion are more helpful than the conclusions. Anyone holding strong prejudicial views on federal land management is advised not to read this chapter unless he is prepared to change his mind.

The list of chapter headings cited earlier had a strong economic tone. The tone is not misleading. The authors are economists and they state explicitly that they are examining management "questions from an economic viewpoint," (p. 4). They have also examined their problems

macroscopically; that is, their discussion deals with such topics as all the public lands, total revenue, disposition of income from public lands, total number of visitors to the National Forests, and similar subjects. The authors are staff members of Resources for the Future, Inc., a foundation concerned, presumably, with all resources on at least a national scale, hence their broad coverage and interests are understandable. Moreover, it is quite possible that no one else in the country is as well qualified as Mr. Clawson to discuss the over-all use and administration of all the public lands. The volume, as I have tried to make clear, is a splendid book. It sets a very high standard for other volumes now issuing or about to come out by the RFF Foundation research staff to measure up to. It is, however, simply the last of a long series of studies which examine all or parts of the same general questions in the same general way. The authors list ten such volumes in a footnote on page 16, and they have not exhausted the list. One of the major theses of the book is an interpretation of the present era as a transition period from custodial management to intensive management. This reviewer would like to advance the suggestion that an era of intensive management will demand a transition also from general macroscopic studies of public land management and use as exemplified in this volume to microscopic intensive research on the same problems. The authors indicate their awareness of this need by making suggestions for additional research at numerous places in their volume. In the pursuit of this intensive research, probably nothing will prove more useful as a source for background and information and as a sensible, informed guide through the complexities of the problems involved than *The Federal Lands*.

WESLEY CALEF

University of Chicago

Water for Industry, JACK B. GRAHAM and MEREDITH F. BURRILL, Edits. vi and 131 pp.; maps, illus., diagrs., tables, index. Publication Number 45, The American Association for the Advancement of Science, Washington, 1956. $3.75. 9¼ x 6 inches.

The American Association for the Advancement of Science has presented us with a brief and quite varied treatment of a timely subject, industrial water. The papers included in this book are the results of a symposium on water for industry held at the 1953 meetings of the Association. The contributors to this volume have provided the teacher of geography with valuable material for such courses as the geography of industry and conservation of resources. The reader is soon aware that the papers fall into two groups: those treating the subject material in a very general way, and those illustrating a specific problem in a certain part of the country. Geographers and conservationists are provided with facts and figures to illustrate a variety of water problems in the United States. We are constantly aware of the interdependence of the various water use factors in an area. C. G. Paulsen, Chief Hydrologist of the Geological Survey, in speaking of water problems points out (page 11) that the hydrologists, planners, engineers, lawyers, and bankers "must all take a hand in these problems in logical sequence and with realistic vision."

The reviewer finds the paper "Water Supply and Waste Disposal Requirements for Industry" by Powell and Knoedler a particularly valuable one for a geographer. We are made aware of such topics as the variation of water hardness in comparison with river flows. Illustrations for this relationship are drawn not from just one river, but from the Scioto, Missouri, James, and Delaware Rivers. Included, too, are the summer temperatures of municipal water supplies for a host of cities from Atlanta to Sacramento. We are supplied with per capita figures of water consumption for some Scandinavian cities from 1900 to 1950. It is felt that the inclusion of this pertinent material will aid the geographer in the assessment and comparison of his local water problem with those in other parts of the world.

A book of this nature gathers valuable information on industrial water into a single collection. No doubt it would best serve as a reference for those specializing in water utilization. This does not mean, however, that the geographer with only a general interest in the subject would not find *Water for Industry* of value. For him it supplies a brief resume which is easily read.

ERICH F. BORDNE

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The Economics of Soviet Steel, by M. GARDNER CLARK. xiv and 400 pp.; map, tables, appendices, bibliogr., index. Harvard University Press, Cambridge, 1956. $7.50. 9½ x 6½ inches.

This is the first full-length treatment of a major Soviet industry to be published by the Russian Research Center at Harvard. On the basis of its intrinsic merits as well as its origin it is an important contribution. The book is divided into four parts dealing with: production and investment, problems of specialization and scale, location and potential development, and productivity. Within this framework geographers will find much of value in Clark's analysis of two closely related problems to which he devotes major emphasis: namely, the *location* of the industry, and its *potential* in terms of

attained levels of production and productivity as well as future prospects.

Locational problems come to the fore in Part II and are dealt with at length in Part III, the latter comprising half of the book with separate chapters on major raw materials and other locational factors. The broad outlines of the changing Soviet locational policy and the resulting pattern of the industry are well brought out; the emphasis on large-scale, specialized plants during the first two Five Year plans, the growing transport crises which contributed to the change in policy with the Third Five Year plan calling for economy in transport and a more "rational" location of industry in relation to markets and materials, the effects of the German invasion, and post-war reconstruction and expansion through 1954.

The analysis of these developments and policy shifts is based on a wealth of material from Soviet sources, elaborately footnoted and supported by an extensive bibliography and detailed appendices. The book, therefore, serves as an excellent guide to the original sources and a useful compilation of statistical data as well as a vehicle for the author's analysis and interpretation. The reader is given insight into the mechanics of locational decisions in a planned marxist economy, in which, at times, there was considerable conflict of interest and public difference of opinion. In the late 1920's the unsuccessful opponents of the large-scale policy, particularly in connection with the Urals-Kuznetsk project, sometimes formulated their arguments in Weberian terms. The victors in this controversy "ignored or underestimated the law of diminishing returns, costs of transportation and the needs and problems of the consumers." Also, in their analysis of the American industry, they failed to appreciate the locational significance of the large and geographically concentrated American market for steel, as well as the fact that this market was supplied by a number of small plants in addition to the large-scale giants which the Russians sought to duplicate. Such appreciation came later. Clark traces the growing recognition of the locational importance of transport costs and the market factor which accompanied the change in policy in 1938–39 with its attendant castigation of "gigantomania" and "over-specialization" as sins perpetrated by Trotskyist and other "wreckers."

In the chapters on specific locational factors in Part III we find the first detailed treatment of this problem in English. In the USSR, as in other major steel-producing countries, the decrease in the amount of coal and increase in the amount of iron ore necessary to produce a ton of steel has shifted the locational attraction of these two materials somewhat in favor of iron ore. Soviet statistics do not allow the degree of this change to be quantified, but it is evidenced by the importance of iron-ore locations for plants built since 1930. Clark shows that the growing recognition of the market factor in Soviet literature has been accompanied by changes in pricing. Prior to 1938, the ton-mile transport rates on iron and steel were *below* those for coal and iron ore in direct contrast to western practice. Subsequently, more rapid increase in transport rates on finished products has changed this relationship and strengthened the "pull" of the market. Also, in 1950 an f.o.b.-consumer pricing system (on a regional basis) replaced the f.o.b.-mill system that had been in effect. As a result, savings in transport costs on finished products became a direct concern to the steel industry's own marketing organization, modifying the traditional separation between production and transport function in the Soviet economic organization and planning. Although the use of scrap increased, especially right after the war, the industry still is suffering from the scrap shortage of a newly-industrialized economy. The crude steel: pig iron ratio in 1954 was only 1.39 in comparison to that of 2.07 in the United States. As is well known, both market and scrap supplies were given greater emphasis in planning the location of the new plants begun during the period 1939 to 1954. However, Clark maintains that insufficient consideration was given to the locational advantages of Leningrad's scrap supply in the decision to locate the new "Northwestern" plant at Cherepovets, 270 miles east of Leningrad, to depend primarily on long hauls of ore from low-grade deposits in the Kola peninsula and coal from Pechora.

The role of transportation in location is presented by means of a case study of the Urals-Kuznetsk problem which traces the controversy surrounding the original planning, the effect of the development upon the transport system, and the subsequent efforts to deal with the resulting problem. Clark concludes that a more realistic appraisal of the transport problem in the initial stages would have stimulated the search for solutions and, perhaps, have speeded a rail link with the Pechora coal fields upon which, he maintains, the continued production and future expansion of the Ural steel plants must depend.

A chapter on "The Resulting Locational Pattern" concludes Part III. Production figures by broad regions (South, Center, and East) from 1913 through 1950 are cited to support the contention that the regional pattern was relatively stable down to World War II. For, despite the emphasis on the Ural-Kuznetsk combine, the East's share in national production rose only from 20 per cent in 1913 to 28 per cent in 1939. The South clearly retained its dominance until the "hammer blows of the German army forged a new locational pattern." This is something of an over-simplification. Clark prefers to view this development in the 1913–1939 perspective. However, his data show that most of the relative change occurred in the years 1931–1936

during the period when the new plants in the East were coming into production. It could be argued that this represents a significant regional shift in capacity for a "non-shifting" industry, despite the stability in the regional pattern from 1936–1940. There can be no doubt that the German invasion and destruction of the Ukraine was a "location factor" of importance, speeding the regional shift which increased the East's share of the 1950 national production to 47 per cent for pig iron and 55 per cent for ingot steel. However, it is equally clear that an expansion of this magnitude could not have taken place without the existence of the eastern plants planned and built during the first two Five Year plans. They also could have been the basis for an increase in relative importance in the East had the Germans not intervened, just as they are at present the basis for the renewed emphasis, in the Sixth Five Year Plan, on development in the East.

Interwoven with the discussion of locational factors and pattern is consideration of the second major problem: the Soviet potential as a producer of iron and steel. The chapters on coal and iron contain detailed evaluation of the economically significant reserves in regard to quality, quantity, and the problems connected with their utilization. Much evidence is cited leading to the conclusion that "shortages of high-grade ore and good coking coal impose series limitations on the expansion of the Soviet iron and steel industry, but, of course, these limitations are not absolute." A major counterbalancing factor is the substantial increase in productivity which is discussed in Part IV. Here we see that pre-war levels of productivity had been regained by 1946, and by 1954 average productivity of blast furnaces had increased further by 45 per cent, and steel furnaces by 61 per cent. These increases, not anticipated by the Russians themselves, made it possible to meet production goals with less investment in new facilities. They also contributed to the growing importance of the Urals and Kuznetsk where productivity was higher than the national average. Clark documents from Soviet sources the many technical developments and applications, especially in furnace operation and ore preparation, relative to this trend, and cites the corroboration to be found in the reports of the British steel mission which visited the USSR in 1955. In a final balancing of technique, labor supply, raw material sources, and the transport problem Clark comes to the somewhat pessimistic conclusion that "continued expansion of Soviet steel production at the current rate of three or four million tons a year is possible only by means of immense capital investments." Whether this is an overly pessimistic view remains to be seen. It is possible that the economic returns on previous investment together with a high level of technical efficiency may make future investment more productive and may, even in the Urals-Kuznetsk, lessen the restrictions of resource quality and the transport problem. Clark is careful to point out that other nations are faced by problems of depletion of high-grade ore deposits, while the study itself reveals the Soviet willingness to invest heavily in this industry.

Clark has done a masterful job in selection and analyzing a mass of scattered, incomplete, and sometimes contradictory material. At one point, however, his analysis would have been sharpened if he had allowed himself to speculate a little concerning the implications of the data he used. In discussing the transport problem, he quotes from a Soviet study by L. P. Shul'kin which "provides a detailed picture of the excessive transport of iron and steel products in 1938." Representative of the examples cited is that of a mill at Nikopol which produced 34,792 tons (53 per cent of the national total) of a particular type of seamless tube of which "only . . . 11 per cent [was] consumed in the [local] oblast. The remainder was shipped *all over* the Soviet Union" (reviewer's emphasis). But when the supporting table is analyzed geographically, on the basis of distance to the principal cities of the various districts, we see that an additional 41 per cent (making a total of 52 per cent) was marketed within 300 miles of Nikopol (Kiev, Kharkov, and Rostov), a further 35 per cent was marketed within the 300-600 mile range (mostly in the Center), and only 4 per cent at localities farther from Nikopol than Leningrad (900 miles). This appears as a reasonable distribution pattern, quantity decreasing with distance from the point of production. It compares well with 1939 data for the United States where a three-day sample of rail shipments of plates, bars, sheets, strip, and angles showed, on the average, that 49 per cent of the carloads moved less than 300 miles, 35 per cent to the 300–600 mile range, and 5 per cent farther than 900 miles. (Board of Investigation and Research, *Economics of Iron and Steel Transportation*, p. 70.) In the above Soviet situation would transport savings, charges on raw materials included, have resulted if this marketing pattern had been served from two or more plants? If so, would the savings have been counterbalanced by dis-economies of smaller scale units? Were there sufficient technical personnel and equipment to operate additional plants of this type at this time? Clark gives us no indication that the Soviet writers considered these questions, even in retrospect. Definitive answers are, of course, impossible for an outsider. But judgment as to the soundness of locational decisions and patterns involves consideration of alternatives, and speculation along these lines might have been fruitful in evaluating the relationship between locational decisions in the steel industry and the transport problems of the railroads.

Neither this criticism nor future develop-

ments can detract significantly from the value of this study. No student of the Soviet economy can afford to miss it, while researchers on the economics and geography of Soviet steel will remain under obligation to Professor Clark for having broken new ground in a complex and difficult field.

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Erde und Weltwirtschaft. Ein Handbuch der allgemeinen Wirtschaftsgeographie. Edited by RUDOLF LÜTGENS. Franckh'sche Verlagshandlung, Stuttgart. Vol. 4: Allgemeine Geographie des Welthandels und des Weltverkehrs, by Erich Otremba. 342 pages, 79 text figures, 19 photo plates, bibliogr., index. Stuttgart, 1957. Linen, 42 DM. 6½ x 9½ inches. Vol. 5: Der wirtschaftende Mensch als Gestalter der Erde, by Edwin Fels. 258 pages, 51 text figures, 27 photo plates, bibliogr., index. Stuttgart, 1954. Linen 30 DM. 6½ x 9½ inches.

With these two volumes the *Handbook of General Economic Geography* has been completed. Together with Lütgens' two volumes (*Die geographischen Grundlagen des Wirtschaftslebens*, 1950, and *Die Produktionsraeume der Weltwirtschaft*, 1952), and Otremba's first contribution (*Allgemeine Agrar- und Industriegeographie*, 1953), reviewed in ECONOMIC GEOGRAPHY, Vol. 31, 1955, pp. 93–94, we now have before us a compendium of economic geography as it is conceived by three outstanding German geographers. This review will first dwell on the last two volumes before attempting to appraise the work as a whole.

As in the previous volume with agriculture and industry, Otremba seemingly has faced a dualism which, however, was much easier to resolve. Trade and traffic (or transportation), after all, form an often inseparable unit. One can't exist without the other if we understand the terms *sensu lato*. They are both derived from the same root "trans," involving movement of some kind, visible or invisible. In the author's words "trade is the primary economic expression of man's desire for exchange . . . and it serves itself by means of transportation. Trade and traffic are hyphening production and consumption. The major task of this book is to analyze trade and traffic movements with regard to their geographic bases and components, their origin, routes and destination, and their effect upon the [economic] landscape" (p. 22).

In the first of three major parts the author elucidates the role of man as the decisive factor in the triangle, space-goods-man. Man is considered as the prime mover as well as a moving object. In a short history of trade we are led from the stone age to the medieval discoveries and to the creation of a world-wide trade realm with, first, the Mediterranean and then Western Europe as its foci. We learn in passing that the number of annual pilgrims to Mecca fluctuated between 300,000 and 11,000 in the last 150 years, that the Swiss alps teem with tourist huts, and that Hamburg's Billbrook district has a large number of in- and out-commuters (work, tourism, religion as motivations for human traffic). To conclude the first part the author discusses various economic formations (such as the colonial economy of the tropics, agricultural and industrial regions) with respect to their needs (food, clothing, shelter, culture) as incentives of trade. A beginning is here made to a geography of consumption which, in the author's opinion, has been very much neglected in the past.

In the second part the three major tangible elements of the trade-transportation complex are scrutinized: the routes, the markets, and the goods. In the chapter on routes it is interesting to note that more pages (33) are devoted to shipping lanes than to all other transportation routes (railroad, street, air) combined, a pardonable literary environmentalism perhaps, since both editor and author are residents of Hamburg an der Elbe. From age structures of tanker fleets to safety installations in the North Sea, to the history of the harbor of Valencia, we really learn a lot about the navigational business. In the discussion of the market, this concept is stripped of its "economics" flavor. The "geographic market" becomes part of the economic landscape; it influences the morphology, the functions, and the hierarchy of towns and cities. Finally, selected commodities, including auxiliary means of trade such as telecommunications, capital, and mail, are investigated "in their movement over the earth," with the author trying hard and successfully to bring life into topics usually relegated to statistical appendices.

In contrast to the first two parts of the book the organization of the last one is strictly regional. The earth is divided into "economic realms on the basis of their trade and traffic structure and their interrelations." Natural regions as well as nations are typified with respect to their position in world trade and to the general status of their transportational facilities. To the Federal Republic of Germany a special chapter is dedicated in order to state an example of how a geographer should analyze the trade-transportation complex of a country. The rest of the world gets more of a cursory treatment. In both cases, however, the approach is basically the same: the focus is on the economic landscape as the visible result of man's victory over space.

Otremba's treatment of the topic stands, as does his previous contribution, on a high level both methodologically and factually. It actually is an attempt to establish the field of

trade and transportation as coequal with other subdivisions of cultural geography. The time was undoubtedly ripe for this with former works in German on the same topic long out of date (Friedrich, Andree, Hassert, Partsch, Sapper, and others). It is Otremba's merit that he has not only picked the ripe fruit but created a new variety. His book is a methodological guide, full of facts in words, maps, and figures, and last, but not least, messenger for a potential and possible better use of the earth, all in one.

Der wirtschaftende Mensch als Gestalter der Erde (verbally translated into an awkward "economic man as sculptor of the earth"), written by Altmeister Fels of the Free University of Berlin, shows in a rigidly systematic way how man has transformed nature into economic landscapes and how he himself has changed in the "vortex of transfigurations" ("im Wirbel des Gestaltswandels der Erde"). Man has moved the earth for settlement, to sow and harvest, for minerals, to move about; he has domesticated water bodies, natural vegetation and wild animals, and, to a certain extent, even weather and climate. Under chapter headings like these, landscapes from all over the earth flash by kaleidoscopically. It all began with mound builders and cliff dwellers and it seems to end with "metropolitan anemia" and "American neurosis." So the end is reflective: "The economic landscape is beautiful and a thing of joy where in harmony with laws of nature, . . . regrettable and ugly where negligence and stupidity reigns. . . . We have the high responsibility to work with the earth, with our Mother Earth, in such a way that some day we may stand unabashed before our progeny" (p. 243).

Volume 5 had an anticlimactic effect on this reviewer. One cannot help noticing the occurrence of reiterations and outright duplications of material already treated in previous volumes. In a handbook of this scope this is, of course, difficult to avoid and in some cases even justified insofar as any landscape can be approached from different angles, significant changes might have taken place, or more recent source material might have become available. The Ruhr area, for instance, is treated in Volume 1 with the discussion of mineral resources, as the Rhein-Westfalen industrial district in Volume 2, in Volume 3 under various aspects of manufacturing, then it comes back in the next volume as an example of transportational integration, and finally in the last one as an industrial landscape par excellence. Similar disjunct but complementary attention is given to many other topics while duplications are apparent in the description of the Zuider Zee, the agriculture of the United States, the duration of freezing on Russian rivers, the time zones. Unfortunately, it is very difficult to obtain full information about a certain topic or area because both the regional and topical indices are unsatisfactory.

A review in an American periodical, and particularly in this one, should probably take issue with a rather direct attack on American economic geography by Fels (p. 8): "Economic Geography in the United States, it seems to me, is in need of revision despite all advantages of the textbooks. In contrast to the uniform concept [?] of German geographers our U. S. colleagues generally exhaust their Economic Geography by offering nothing but a Commodity Geography." Professor Fels is obviously misinformed, if not uninformed about the status of the field in this country. I am quite sure that he takes the textbooks as representative of the latest research efforts by his United States colleagues. Then, and this is quite a coincidence, there exists a book printed in this country which has, for all practical purposes, the very same title Professor Fels used for his book. "Man's role in changing the face of the earth" might go far in changing the accuser's ideas about what American economic geographers really think and do.

Having scanned the five volumes let us ask the final question: Has the purpose of the handbook been fulfilled, i.e., do we have "a modern and exhaustive handbook and textbook of Economic Geography" (Vol. 1, p. 1)? Allow me to use a simile. The building here standing before us and called economic geography is like a cathedral exhibiting styles of at least two different periods. It is a monumental structure, highly complex, or even heterogeneous. It was built with one purpose in mind, and the architects served it with different ideas, with different means. Lütgens built the fundament and the containing walls in solid style, Fels meticulously laid the roof tile by tile, but neither senior author always using the most recent building material. The interior decoration was done by Otremba in bold, modern mosaics. After you have studied the whole for a while you realize that the outer structure was necessary to give a sufficiently contrasting background to the mosaics. Two generations were at work, and the results show that even though methods and techniques change, faith didn't. If nothing else this demonstrates that economic geography is a living science and will always be, as long as man feels, to speak with Hellpach, the urge to landscape the earth.

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